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Model ASP-1

Analog Smart Portable Technical Manual

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Thermo Instrument
Systems Inc.

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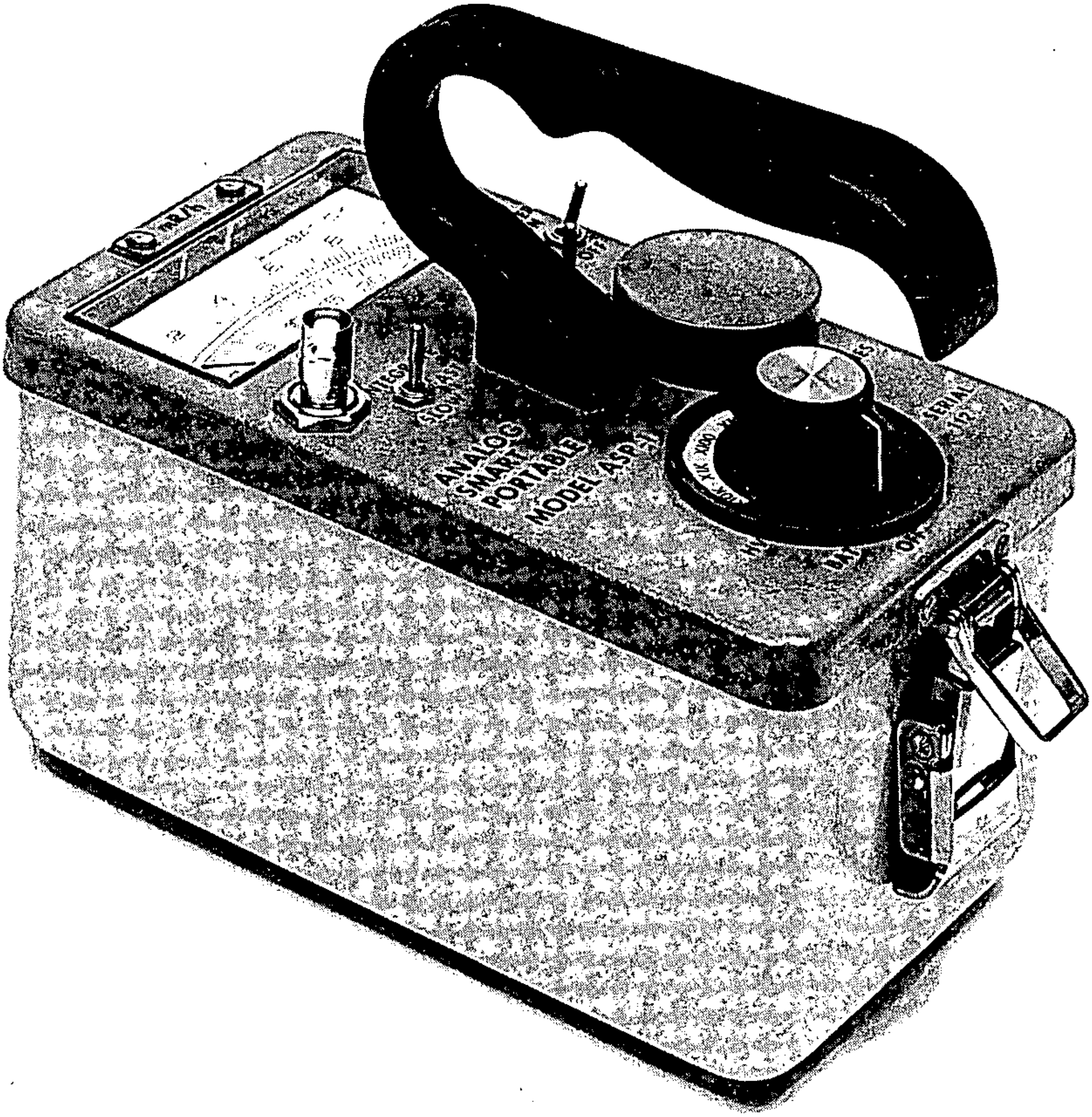


Figure 1-1. Analog Smart Portable, ASP-1

SECTION I
GENERAL

A. PURPOSE AND DESCRIPTION

The Eberline Model ASP-1, Analog Smart Portable, is a microcomputer-based portable radiation measuring instrument designed to operate with most Eberline radiation detectors. The ASP-1 retains the simplicity of a meter display while adding the capabilities of a computer. The computer compensates for detector resolving (dead) time, provides an alarm if the radiation is higher than the detector is capable of measuring, provides various meter response times and permits a large number of operating ranges. The ASP-1 displays both detection rate (mR/h, etc.) and integrated amount (mR, etc.).

The ASP-1 is designed to accommodate a wide variety of detectors, radiation units and ranges with a minimum of actual changes to the instrument. The user can readily make these changes to meet new requirements as they occur.

Other ASP-1 features include a speaker, acoustic type earphones, a lighted meter, a meter *RESET* switch and a *SLOW-FAST-INTEGRATE* response switch.

Options include an internal GM detector (only) and a single channel pulse-height analyzer (PHA) circuit on an additional plug-in circuit board. (The detector pulse amplitude must be related to radiation energy in order for PHA to be useful.)

B. SPECIFICATIONS

1. Meter: Dual scales, approximately 3 inches long.

The lower scale indicates from 0 to 2500 volts (in 50-volt steps), showing the high voltage applied to the detector.

The upper scale has universal 0 to 1.0 markings (50 increments) to represent the radiation being measured. A changeable units label (*mR/h, CPM,* etc.), located immediately above the meter, shows what radiation units are in use. The meter has a battery condition mark to indicate when the batteries should be changed.

2. Range of Operation

a. Rate. The full-scale count rate for the ASP-1 is between approximately 20 counts per minute (cpm) and 3 million cpm, true count rate from the detector. With dead-time correction, the meter indication may be equivalent to as high as 5 million cpm.

A circular multiplier dial around the range switch has eleven multipliers (X.001 through X10M in decade steps), six of which are visible at any one time. The six multipliers are selected according to the units (mSv, R, rem, counts, etc.), the unit time (per sec, per min, per hour) and the sensitivity (pulses per roentgen, etc.) of the detector to be used. See section VII, "Detectors and Accessories," for typical setups of specific detectors.

b. Integrate. In the *INTEGRATE* position of the response switch, the ASP-1 reads the integrated total amount of the same radiation unit as used in the rate positions. (If the rate unit is mSv per minute, the integrated total will be in mSv, etc. The range switch may have to be moved to bring the integrated reading on scale.) The maximum integrated reading is full scale on the highest range setting.

3. High Voltage Output: The voltage at the detector connector is adjustable from +300 to +2500 Vdc with no load connected (GM, proportional chambers, etc.) and up to +1600 volts with a 100 MΩ (or more) load connected. The high voltage is displayed on the meter in the *HV* position of the range switch.

4. Detector Connector: MHV series coaxial.

5. Detectors

a. External Detectors: Most Eberline GM, proportional, or scintillation detectors for alpha, beta, gamma, or neutron detection may be used on the ASP-1. The detectors recommended are described in section VII. The detectors connect to the ASP-1 via an MHV series coaxial connector located on the top of the instrument. Other detectors may be used provided they connect with a single coaxial connection, operate with positive bias, do not overload the high voltage supply and provide more than one millivolt of pulse signal.

b. Optional Internal Detector: When this option is installed, an energy compensated GM tube, located at the front of the case, provides a self-contained radiation measuring instrument. The useful range of operation is from 1.0 mR/h full scale to about 50 R/h (depending upon the GM characteristics), where the overrange alarm will be given.

6. Input Sensitivity: Adjustable from 1 mV to 50 mV. When the optional pulse-height analyzer (PHA) is installed, the threshold range is 1 to 20 mV and the window is adjustable from 0 to 20 mV, always referenced to the adjustable threshold.

7. Paired Pulse Resolution: Two microseconds (μs), pulse height twice threshold; with PHA installed, 5 μs.

8. Response Time, Rate Function: The response time is determined by the microcomputer based on input count rate. In the *FAST* postion of the response switch, a maximum five percent standard deviation (SD) is maintained at count rates above 2500 cpm. Normal response time limits are one to ten seconds. This 10-second limit causes a SD of 11 percent at 600 cpm and 34 percent at 60 cpm.

To improve reading precision at low count rates, a longer response time of 29 seconds can be initiated by selecting the *SLOW* position on the response switch. This allows the SD to be maintained at 3 percent or better for a response time of up to 29 seconds. This 29-second limit causes a SD of 6 percent at 600 cpm and 20 percent at 60 cpm.

When operating on the three higher range switch settings, a fast response time is maintained, made possible by the higher incoming count rates. Also, when the third most sensitive range is in use, if the latest computed count rate is significantly different from the previous computed average rate, a jump to the new rate is made in order to shorten the time needed to indicate the new average rate. This speed-up is not possible on the two most sensitive ranges because of the difficulty in analyzing the very low and random incoming count rates.

9. Linearity: Electronics and meter, ±3 percent of full scale. When properly calibrated, the typical maximum nonlinearity due to detector dead time is ±20 percent of the reading when operating below the point where the microcomputer determines an overrange condition and gives an alarm.

10. Detector Dead-Time Range: Set by switches from 0 to 254 μs in steps of 2 μs.

11. Calibration Controls: One set (multipliers and calibration potentiometer) calibrates all ranges. The computer sets in new exact calibration factors when the range switch is moved.

12. Overrange Indication: When the radiation rate exceeds the useful range of the detectors, the computer will cause an overrange alarm. At alarm, the meter needle will sweep back and forth and an interrupted tone will sound in the speaker. The alarm will continue until the ASP-1 is turned off (and back on for further operation).

13. Light: The meter is illuminated when the spring-loaded *LIGHT* switch is held on.

14. Speaker/Phones: A *SPEAKER OFF-ON* switch controls the detector pulses to the speaker. A speaker countdown circuit permits dividing the speaker rate by 16, 64 or 256. The countdown circuit is useful when very sensitive detectors are used.

A phone adapter is provided to connect to an acoustic (airline-type) headset.

15. Batteries: Six C-cell size batteries. The life of six carbon-zinc batteries is variable from about 150 to 250 hours, depending on the high voltage power required, the speaker usage and the light usage. Alkaline batteries will last nearly twice as long under the same operating conditions. The *BAT* position of the range switch checks the battery condition.

16. Overall Dimensions: 4.2 inches wide x 7.9 inches long x 6.2 inches high (10.7 cm x 20 cm x 15.7 cm), including handle. The probe clip, if installed, adds 1 inch (2.54 cm) to the height.

17. Weight: 2.8 pounds (1.3 kg), with carbon-zinc batteries.

18. Environmental: Operating temperature, −40 °F to +122 °F (−40 °C to 50 °C). For operation below 0 °F (-18 °C), alkaline or nickel-cadmium batteries should be used. Seals are used at case openings to provide splashproof operation.

SECTION II
OPERATION

A. DESCRIPTION OF CONTROLS & CONNECTORS

1. External

a. Range Switch: A nine-position rotary switch used to turn the ASP-1 on, check the batteries, check the high voltage and select a range of operation. The multiplier selected is the full scale value of the units of radiation because the meter scale is marked 1.0 at full scale.

b. Response Switch: In the *FAST* position, the response time is selected by the computer for typical survey work. When the *SLOW* position is selected, the response time is made longer for a steadier reading. In the *INTEGRATE* position, the meter shows the total radiation detected since the last time it was reset to zero (or since the instrument was turned on if it has not been reset).

c. *LIGHT-RESET* Switch: This triple-function switch is spring-loaded to return to the center (*OFF*) position. When it is held in the *LIGHT* position, the meter is lighted. When operating in the rate mode (*SLOW* or *FAST*) momentarily pressing the *RESET* switch will drop the meter toward zero. If the switch is held in the *RESET* position, the meter will go to zero and remain until the switch is released. (If in the *FAST* or *SLOW* position and the *RESET* switch is held for 5 seconds, the meter will indicate the "standard" current. (See part D of this section and section III.B.8. for description). The integrated count will not be zeroed when in a rate mode. If the integrate mode is in use, pressing the *RESET* switch will set the integrated count to zero. A new integrate period begins when the *RESET* switch is released.

d. *SPEAKER* Switch: When *ON*, the detector pulses are heard on the speaker, either at full rate or divided down according to the setting of the count down switches. When *OFF* is selected the detector pulses are stopped, but if the computer senses a detector overrange condition the alarm tone will be heard.

e. Detector Connector: MHV series coaxial connector to connect to an external detector. If the internal detector option is selected, this connector is omitted and the hole is plugged.

WARNING

The ASP-1 high voltage power supply is capable of supplying 2500 V to the detector connector. The voltage reduces slowly when the instrument is set to *OFF*. **Use caution.**

f. Phone Adapter: Acoustic (airline-type) head phones plug into holes in this adapter to pick up the speaker sound.

2. Internal, Main Circuit Board

a. *HV ADJ*: This control adjusts the detector high voltage.

b. *HV CAL*: This control is used to calibrate the meter reading when the *HV* position of the range switch is selected. *HV CAL* adjusts the meter to read the actual high voltage value.

c. *5 V*: This control is used to set the output of voltage regulator A101 to 5 volts.

d. *CAL*: This control is used to calibrate the meter reading to agree with the input from the detector. The *CAL* potentiometer provides the fine control while the two *CAL* switches provide the coarse control. See *CAL* switches below.

e. *THRESH* and *GAIN*: These controls work together to determine how large a pulse is required from the detector in order to be counted. The normal minimum pulse-height range is from 1 to 50 mV. (If PHA is installed, the range is from 1 to 20 mV).

f. *DEAD-TIME* Switches: These seven switches, marked *2, 4, 8, 16, 32, 64, 128 μSec*, are additive and are set (closed) to correspond to the resolving (dead) time of the detector being used. The computer uses these settings to correct for lost pulses that would have occurred had the detector been fully recovered from the previous pulse. (When the optional PHA is in use, the ASP-1 dead time correction may be ineffective.)

g. Time Switches: These switches, labeled *MIN* and *HOUR*, are set (closed) according to the basic time used in the rate mode (per sec, per min, per hour). They affect the calibration of the integrate function but have no effect on the rate mode. (When neither switch is set, per second is assumed). When both switches are closed, the computer will indicate the error by sweeping the meter needle back and forth when in the integrate mode.

h. *TEST* Switch: This switch permits automatic testing of the ASP-1 functions by outside testing equipment. The switch must always be in the closed position for the ASP-1 to operate.

i. *CAL* Switches: These two switches are used in conjunction with the *CAL* potentiometer to make the meter reading agree with the detector input. When *CAL* switch "3" is closed, a 1.78 times boost is provided and switch "4" gives a 3.15 times boost. Used together, they multiply to provide a 5.6 times boost in meter reading.

j. *SPEAKER RATE DIV* Switches: These four switches are used to reduce the speaker rate to provide a more meaningful sound from the speaker when the detector count rate is high. They are closed singly to divide the rate by 1, 16, 64 or 256.

k. Circuit Board Edge Connection: The 24-contact (12 top, 12 bottom) edge connector area is used to connect the ASP-1 to a special test set. It has no function in normal operation.

l. *PHA* Socket: A 16-pin DIP socket labeled *PHA* makes the connection to the optional PHA circuit board. When this option is not in use, a jumper header is plugged into the socket to make necessary connections.

m. Optional PHA Assembly

1) *PHA-GROSS* Switch: This switch is used to enable or disable the PHA function. In the *GROSS* position, all pulses above the threshold level are counted.

2) *WIN*: This control sets the acceptance range for the pulses from the detector when PHA is in effect. This range is always related to the threshold setting, moving up or down as the threshold level is changed.

B. PREPARATION FOR USE

1. The instrument must be set up and calibrated with the detector to be used. The design of the ASP-1 facilitates changing both the detector and the units of measurement (mR/min, Gy/h, etc.). A detailed setup procedure is located in the "Maintenance" section. Typical detector specifications are found in section VII.

2. After checking that the high voltage is correct for the detector, connect it to the ASP-1. (If the internal detector is installed, skip this step. The internal GM tube is located at the front of the ASP-1, near the bottom of the can. Its location is marked on the can).

CAUTION

If the high voltage is excessive for the detector, connecting it to the instrument may damage the detector.

C. USING THE INSTRUMENT

1. Set the range switch to the *BAT* position. The batteries are okay if the meter shows above the *BAT OK* mark. Recheck the batteries during long periods of operation.

2. Select the *HV* position. The lower meter scale shows the voltage applied to the detector.

3. For rate measurements, set the response switch to *SLOW* or *FAST*. Set the range switch to the desired range and read the detector response on the upper meter scale. The units of the measurement are specified by the tag just above the meter and the full scale value is the same as the range switch multiplier number. At low count rates, the needle will fluctuate due to the random nature of radiation emission and detection. When the *RESET* switch is pressed, the reading drops toward zero until the switch is released. (When in the rate mode, *FAST* or *SLOW*, pressing the *RESET* switch does not zero the integration count.)

4. Integration Function

When the ASP-1 is on, it is continually integrating the detector counts. To display the present total (in radiation units), select the *INTEGRATE* position of the response switch and set the range switch for an on-scale reading. The radiation unit for integration is the same as that for the rate mode. (If Sv/h is the rate unit, Sv is the integration unit, etc.)

To begin a new integration period, press the *RESET* switch while in the *INTEGRATE* position of the response switch. The new integration period begins from zero when the *RESET* switch is released. (A rate mode, *SLOW* or *FAST*, may then be selected to prevent accidental loss of the integrated count. The *RESET* switch has no effect on integration when operating in the rate mode).

5. The *SPEAKER* and *LIGHT-RESET* switches may be used as desired.

6. To use the headset, plug it into the phone adapter.

7. Overrange Indication

If the radiation exceeds the useable range of the detector, an overrange alarm occurs (no PHA). At alarm, the needle sweeps back and forth across the meter face and the speaker emits an interrupted tone. To end the alarm, reduce the radiation at the detector, then move the range switch to *OFF* and back on.

The overrange alarm occurs when the count rate from the detector exceeds a precomputed count rate (based on the setting of the dead-time switches) or when the dead-time correction factor exceeds five.

It should be noted that the overrange alarm may occur at any point on the meter face, not necessarily at a full scale reading. Also, the occurence of the overrange alarm is independent of the range switch setting. (The alarm function is active even in the *BAT* and *HV* positions, but only the interrupted tone will be apparent).

When PHA is in use, the overrange alarm will probably be ineffective due to the rejection of those pulses outside of the PHA window.

D. INTERCHANGE OF DETECTORS

An individual detector that has previously been calibrated to a specific ASP-1 may be reinstalled in the field if all the calibration information is available. The calibration record label in the ASP-1 can is a convenient location for this information. The tools required include a small adjustment screwdriver, a larger screwdriver if the meter units label is to be changed, and a 5/64 hex wrench and a 9/16 wrench if the range switch multipliers are to be changed.

To facilitate the field detector change, the ASP-1 has a "standard" current feature which permits precise resetting of the *CAL* potentiometer control. "Standard" current is obtained by selecting any range multiplier position, selecting *SLOW* or *FAST* and then holding *RESET* for more than 5 seconds. The meter reading obtained is dependent only upon the *CAL* control setting and this feature allows precise resetting of the *CAL* control.

Procedure:

1. Range switch *OFF*.

2. Disconnect the detector.

3. Install new meter units label if necessary. A sheet of labels is included in the back of this manual.

4. If different range switch multipliers are needed, remove one battery so the range switch can be moved without turning the instrument on. Remove the knob, remove the switch nut, and rotate the multiplier plate so that the proper multipliers appear in the window. Reinstall the nut and knob. Set the switch to *OFF* and reinstall the battery.

5. Set the dead time switches to the recorded value.

6. Set the *MIN* and *HOUR* switches to the recorded settings.

7. Set *CAL SW 3* and *4* to the recorded settings.

8. Close only one speaker rate divider switch, as desired.

9. Select the HV position on the range switch. Adjust the *HV ADJ* control for the recorded value of high voltage as read on the meter. Do not touch the high voltage circuitry at the front of the circuit board.

10. Select any range multiplier setting. Select *SLOW* or *FAST* and hold *RESET* for more than 5 seconds. Adjust the *CAL* control until the meter reads the recorded "standard" current value (never less than .42).

11. If a change in input sensitivity is called for, refer to section IV.C.2.b. Precise input sensitivities are not required for gross (not PHA) operations.

12. If PHA operation is intended with the new detector, refer to section IV.C.2.h. for set-up instructions. (Method 1. requires no test equipment.)

13. Connect the new detector.

E. BATTERY REPLACEMENT

1. Set the range switch to *OFF*.

2. Remove the bottom case.

3. Remove the old batteries.

4. Install three new batteries with the positive ends inside the red cups.

5. Install the other three batteries with their positive ends against the negative ends of the first three batteries.

6. Replace the bottom case.

CAUTION

Many of Eberline's instruments contain alkaline, carbon, lead, nickel-cadmium or lithium batteries. All batteries contain small amounts of heavy metals and other hazardous materials and must be handled and disposed of properly. Lithium batteries present the following hazards; fire, explosion or severe burn risk. Do not expose the cell contents to water. Recharge only batteries specifically designated as rechargeable and follow the manufacturers recommendations on recharging. Do not puncture, mutilate, or attempt to disassemble, incinerate, or heat above 100°C (212°F). Eberline recommends that all batteries be recycled at appropriate licensed recycling centers or disposed of as required by local ordinances and regulations.

SECTION III
THEORY OF OPERATION

A. GENERAL
(See figure 3-1, System Block Diagram)

The detector is powered by the high voltage power supply. When the detector reacts to radiation, a pulse is coupled to the amplifier. If the amplified pulse is larger than the discriminator setting (and smaller than the window limit, if PHA is in use), the signal is sent to the microcomputer. The computer senses the various switch settings, computes the value and outputs a code to the digital-to-analog (D/A) converter. The resulting analog signal drives the meter.

B. FUNCTIONAL THEORY
(See figure 6-1, General Schematic)

1. Detector

Several types of detectors may be used with the ASP-1. Scintillators, GM tubes and gas proportional probes measuring alpha, beta, gamma, X-ray and neutron emissions are typical. The detector is powered by the positive output of the high voltage power supply. When a radiation reaction occurs, a negative polarity pulse is impressed back on the high voltage line and capacitor C11 carries the signal to the amplifier. See section VII for typical detectors and their setup characteristics.

2. High Voltage Power Supply

Transistor Q10 and transformer T1 form an oscillator circuit. The voltage of the secondary of T1 is highly stepped up. CR10, CR11, CR12, C12, C13 and C15 form a voltage tripler circuit. R11 and C14 help filter this voltage. R13 carries the high voltage to the detector while isolating the detector signal from the high voltage filter. R12 is a very high impedance divider used in a feedback loop to control and regulate the high voltage output. A102-3 is the input to an amplifier which is used as a low impedance follower of the divider signal. A102-1 drives amplifier input A102-15, while the input reference is set by the *HV ADJ* potentiometer. The output of this stage drives Q103, which controls the level of oscillation of the high voltage circuit, thereby completing the feedback loop. A102-1 also drives follower A102-5, 6 and 7, which provides the signal to the meter when in the *HV* position of the range switch. R104 and R105 calibrate this signal.

3. Amplifier

Transistor Q106 and the two operational amplifiers of A103 form the ASP-1 amplifier section. Resistors R131 and R132 set a direct-current reference for the operational amplifiers and a feedback loop through R130 and R123 provides the direct-current bias for the entire amplifier. The *GAIN* control, R128, is normally set at maximum gain (fully clockwise) except when needed to make the instrument less sensitive than is possible by using the *THRESH* control alone.

4. Discriminator (no PHA board)

The amplifier output signal from A103-7 goes through the PHA socket header and through C110 to pin 11 of A103, a comparator input. Pin 11 is direct-current biased at 0 volts (ground potential). Pin 12, the comparator reference, is connected to the wiper of R1, the threshold (input sensitivity) control. When the voltage on pin 12 is adjusted closer to ground, the smaller pulses at pin 11 will reach the threshold level and be counted. Raising the voltage at pin 12 will exclude these smaller pulses.

5. Optional PHA Circuit

When the pulse-height analyzer (PHA) board is installed, the shorting header is omitted. A voltage divider from the +5-volt line is formed by R2, R33, R32 (window), R1 (threshold) and R31. Each of the five resistors has 10 kΩ so each resistor has a nominal 1-volt drop across it. The upper two comparators shown in A106 are the threshold and window comparators. The threshold comparator reference (A106-7) is held at 2 volts and the pulse-driven input (A106-6) is direct-current biased between 1 and 2 volts by the threshold control. Any positive pulse large enough to take pin 6 to 2 volts has crossed the "threshold."

The reference input of the window comparator, A106-5 is adjusted by the window control between 2 and 3 volts. This reference is the "top" of the "window". The pulse-driven input (A106-4) is tied directly to the pulse input pin of the threshold comparator and so it too is direct-current biased between 1 and 2 volts by the threshold control. Any pulse that drives the two input pins up to 2 volts has crossed the "threshold" and has entered the "window" area. If the top of the pulse stays in the window, that is, does not reach the window reference voltage at A106-5, then it is an "acceptable" pulse and will be counted. If the pulse is so large that it exceeds the window reference voltage at A106-5, then it has gone out of the "top" of the "window" and it will not be counted. In this way, the PHA circuit may be set to accept only a small range of pulse amplitudes which may represent a specific radiation energy. Since the threshold crossover point is always at 2 volts and the window reference adjusts from 2 volts upward, the window width is independent of the threshold setting.

If the pulse height is "in the window," A106-1, A106-9 and A107-1 (clock A) go low when the pulse crosses the threshold. When the pulse returns below the threshold, clock A goes high and the first binary in section A of A107 changes state since a positive transition at the clock input advances the counter. The binary output at A107-3 goes high and this signal is carried to the comparator input at A103-11. A103-10 goes low and A105 registers the count. The high at A107-3 is carried to reset pin A107-7 by R42 and CR32 and the binary stage is reset to zero, causing A107-3 to return to a low output. If the pulse height is above the window, A106-1, A106-9 and A107-1 go low as before when the pulse first crosses the threshold. When A106-9 goes low, A106-14 also goes low and C32 is discharged through CR31. When the pulse continues upward out of the window, A106-2 goes low and if S31 (*PHA-GROSS* switch) is closed, A107-9 (clock B) also goes low. When the pulse amplitude comes back into the window on the way down, A106-2 and A107-9 return high and the first binary of section B of A107 changes state (positive clock transition). Pin A107-11 immediately goes high and CR33 holds section A in the reset condition. When the pulse falls below the threshold, A106-1, A106-9 and A107-1 return high. Section A of A107 does not change state because of the reset signal through CR33. As A106-9 goes high, A106-14 goes high, coupling the high through C32 to pin 11. This causes A106-13 to also go high, resetting section B of A107 which removes the reset signal of section A. A106-13 and B reset return low when R39 recharges C32 and pin 11 goes low. The circuit is now ready for the next pulse.

If the *PHA-GROSS* switch is in the *GROSS* position (open), A107 section B cannot hold section A in reset and all pulses above the threshold will be counted.

6. Binary counter, A105

This counter has two functions. The first is to allow a slower speaker pulse rate, if desired, and second, to hold the signal input line to the computer high or low long enough for the computer to sample and detect a level change.

7. Speaker Circuit

Two sections of A104 (pins 1, 2, 3 and 4, 5, 6) form a free running oscillator of about 2 kHz. This oscillator drives the speaker. The other two sections make up a monostable trigger which turns on the oscillator for about 2 milliseconds each time a detector pulse arrives. When the speaker switch is on, CR101 is back biased and the oscillator circuit is not disabled. In the *OFF* position, CR101 is connected to A1-10, normally high, which prevents the oscillator from working.

If the computer senses a detector overrange condition, A1-10 goes low (for 900 out of each 1000 milliseconds), forcing the monostable on and an interrupted tone results.

8. Microcomputer

The microcomputer system consists of computer and program chip A1. In February 1990 a masked ROM version of the computer was introduced. This single chip A1 combined the functions of A1 and A2 used in earlier versions. The EPROM chip A2 (program chip) is no longer used. The on-board clock oscillator runs at 6MHz and the program updates the meter reading every one-half second. (See the program flowchart, figure 3-2.)

Each one-half second:

a. The computer reads, zeros and restarts the on-board detector signal counter and computes counts per second for the one-half second period.

b. The dead-time switches are read and a dead-time (DT) correction factor is computed based on the count rate.

c. The (DT) corrected counts per one-half second value is added to the integrate register.

d. The range switch and *CAL* switches are read and the corresponding calibration factor is selected.

e. A time constant, based on the latest count rate and the *INTEGRATE-SLOW-FAST* switch setting, is computed and applied to the new and old count rates, resulting in a weighted average rate.

f. If rate (*SLOW* or *FAST*) is selected:

The new weighted average rate is multiplied by the calibration factor (from d. above) and the result drives the D/A converter which, in turn, drives the meter.

g. If *INTEGRATE* is selected:

1) The (per) *MIN* and (per) *HOUR* switches are read and the proper time factor is selected.

2) The time factor and the calibration factor (from d. above) and the integrated count are multiplied together and the result drives the D/A which, in turn, drives the meter.

If the *RESET* switch is pressed while in the *SLOW* or *FAST* position, the meter reading goes toward zero for at least one-half second. If it is held at *RESET* for less than 5 seconds, the meter goes to zero until the switch is released. Upon release, the reading will go toward its steady state conditions according to the response time factors. This action does not reset the integration count.

If the *RESET* is pressed while in the *INTEGRATE* mode, the integrated count is zeroed and a new integration period is started when the switch is released.

If operating in a rate mode (*FAST* or *SLOW*), holding *RESET* for more than 5 seconds will cause the D/A to output a "standard" current corresponding to a digital input of 100 (decimal). The meter reading at this time depends only upon the setting of the *CAL* potentiometer, R6, and so this feature allows precise setting and resetting of the *CAL* potentiometer to a predetermined value.

The response time of the ASP-1 is computed according to the incoming signal rate and the *SLOW-FAST* switch setting. If the switch is set at *SLOW*, the weighting factor used in the calculation of the new average rate is made three times as large as when in the *FAST* position. (The weighting factor determines the amount of influence given to the old average rate when calculating the new average rate.)

When operating on the three higher range switch settings, a fast response time is maintained, made possible by the higher incoming count rates. Also, when the third most sensitive range is in use, if the latest computed count rate is significantly different from the previous computed average rate, a jump to the new rate is made in order to shorten the time needed to indicate the new average rate. This speed up is not possible on the two most sensitive ranges because of the difficulty in analyzing the very low and random incoming count rates.

On the three most sensitive ranges, the computed average count rate being displayed is limited to the maximum amount which is slightly above full scale. This assures a rapid on-scale reading of the radiation field changes from very high to "on-scale" again. Simultaneously, the "true", unlimited count rate is being computed and stored so that the higher count rate may be displayed immediately, with no time constant delay involved, if the range switch is moved to a higher range.

Multiplexers A5 and A6 are used because there are more switches to be read than there are computer input ports. A1-12 controls the multiplexers according to the program needs.

Since all of the outside inputs to the computer (except the detector signal) come from mechanical switches and the switches are read every half second, no memory (except the program) need be retained when the ASP-1 is off. In the *OFF* position of the range switch, the batteries are disconnected. When the instrument is turned on, C2 initially pulls the reset pin, A1-9, high to reset the computer to the start of the program.

9. Digital-to-Analog Converter, A4

The D/A is an eight-bit latching input converter. At each half-second update, the computer outputs the data at port 0 and the write bit at A1-16 goes low to strobe the data into the D/A. The date is retained in the D/A latches until the next update. The D/A output signal is not amplifier driven. The current out is a function of the +5-volt supply voltage and the code selected internal resistors. R6, the calibration control, is in parallel with the meter so that the full scale voltage drop of the meter circuit does not vary.

10. Voltage Regulator, A101

A101 is an adjustable direct-current voltage regulator used to provide a stable +5-volt source. The output voltage is adjusted by R15.

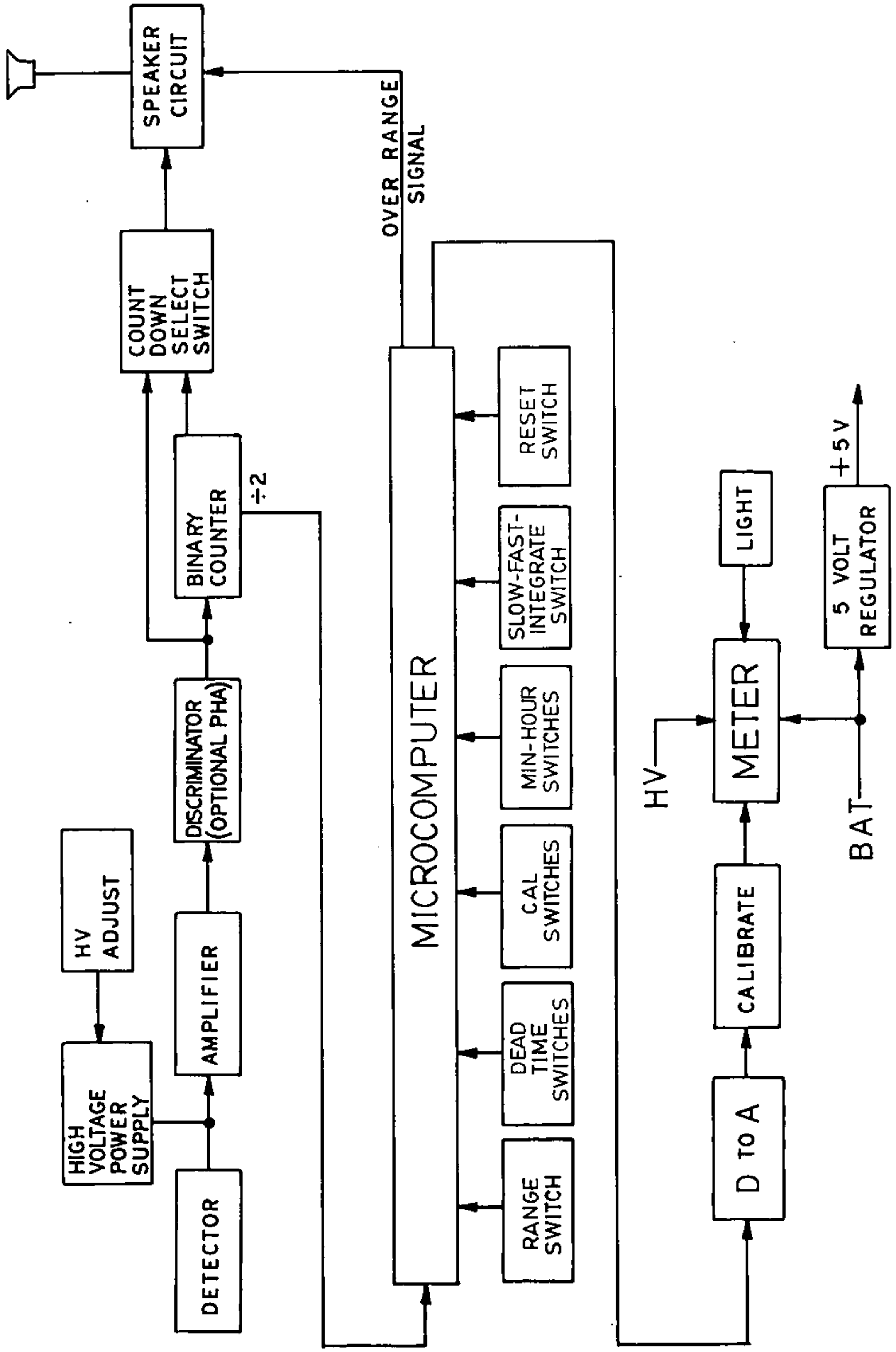


Figure 3-1, System Block Diagram (11338-C15)

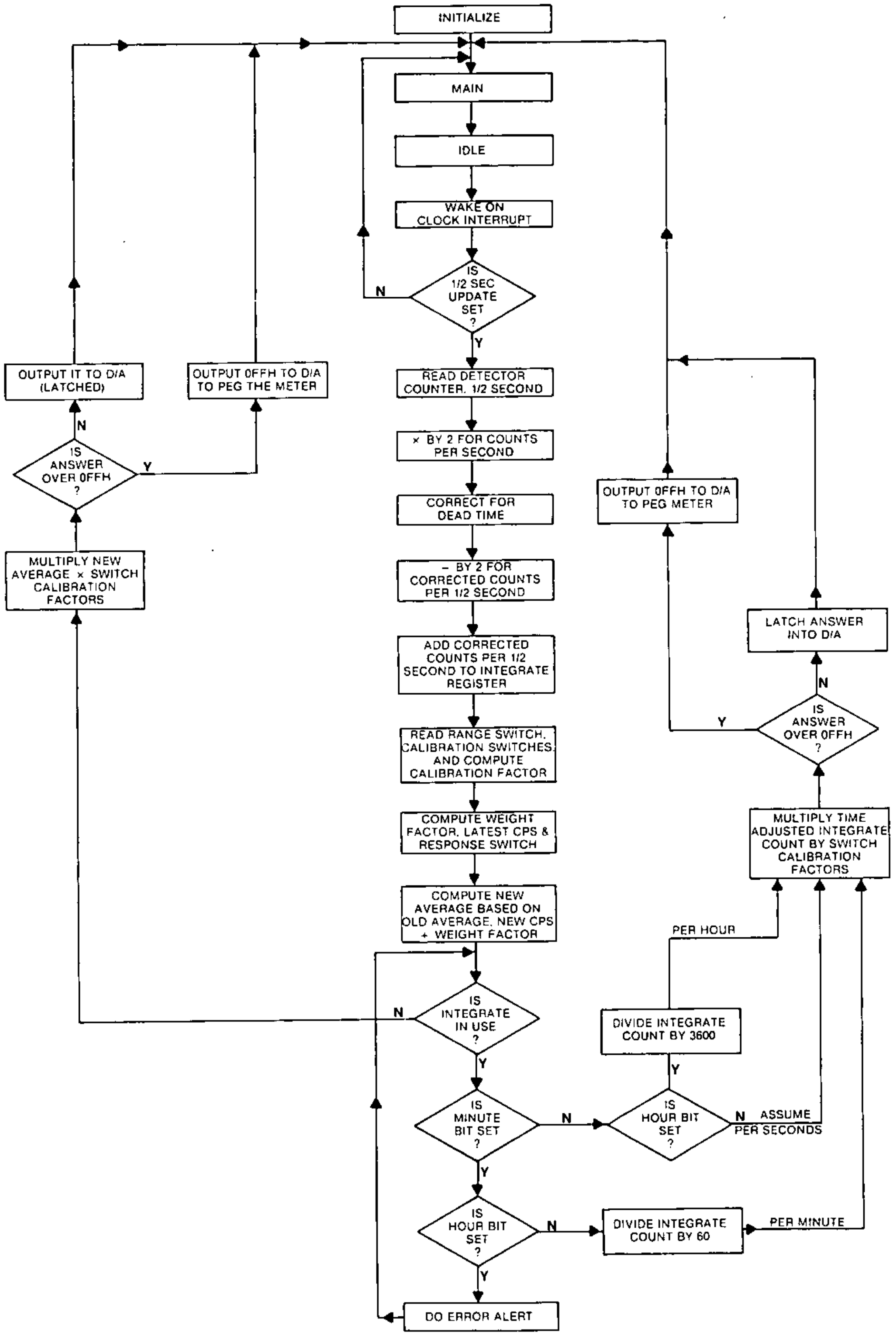

INITIALIZE
MAIN
IDLE
WAKE ON CLOCK INTERRUPT
IS 1/2 SEC UPDATE SET ?
N
Y
READ DETECTOR COUNTER, 1/2 SECOND
× BY 2 FOR COUNTS PER SECOND
CORRECT FOR DEAD TIME
÷ BY 2 FOR CORRECTED COUNTS PER 1/2 SECOND
ADD CORRECTED COUNTS PER 1/2 SECOND TO INTEGRATE REGISTER
READ RANGE SWITCH, CALIBRATION SWITCHES, AND COMPUTE CALIBRATION FACTOR
COMPUTE WEIGHT FACTOR, LATEST CPS & RESPONSE SWITCH
COMPUTE NEW AVERAGE BASED ON OLD AVERAGE, NEW CPS + WEIGHT FACTOR
IS INTEGRATE IN USE ?
N
Y
IS MINUTE BIT SET ?
N
Y
IS HOUR BIT SET ?
N
Y
DO ERROR ALERT
DIVIDE INTEGRATE COUNT BY 60
PER MINUTE
IS HOUR BIT SET ?
N
Y
ASSUME PER SECONDS
DIVIDE INTEGRATE COUNT BY 3600
PER HOUR
MULTIPLY TIME ADJUSTED INTEGRATE COUNT BY SWITCH CALIBRATION FACTORS
IS ANSWER OVER 0FFH ?
N
Y
LATCH ANSWER INTO D/A
OUTPUT 0FFH TO D/A TO PEG METER
MULTIPLY NEW AVERAGE × SWITCH CALIBRATION FACTORS
IS ANSWER OVER 0FFH ?
N
Y
OUTPUT IT TO D/A (LATCHED)
OUTPUT 0FFH TO D/A TO PEG THE METER

Figure 3-2. Computer Program Flow Chart

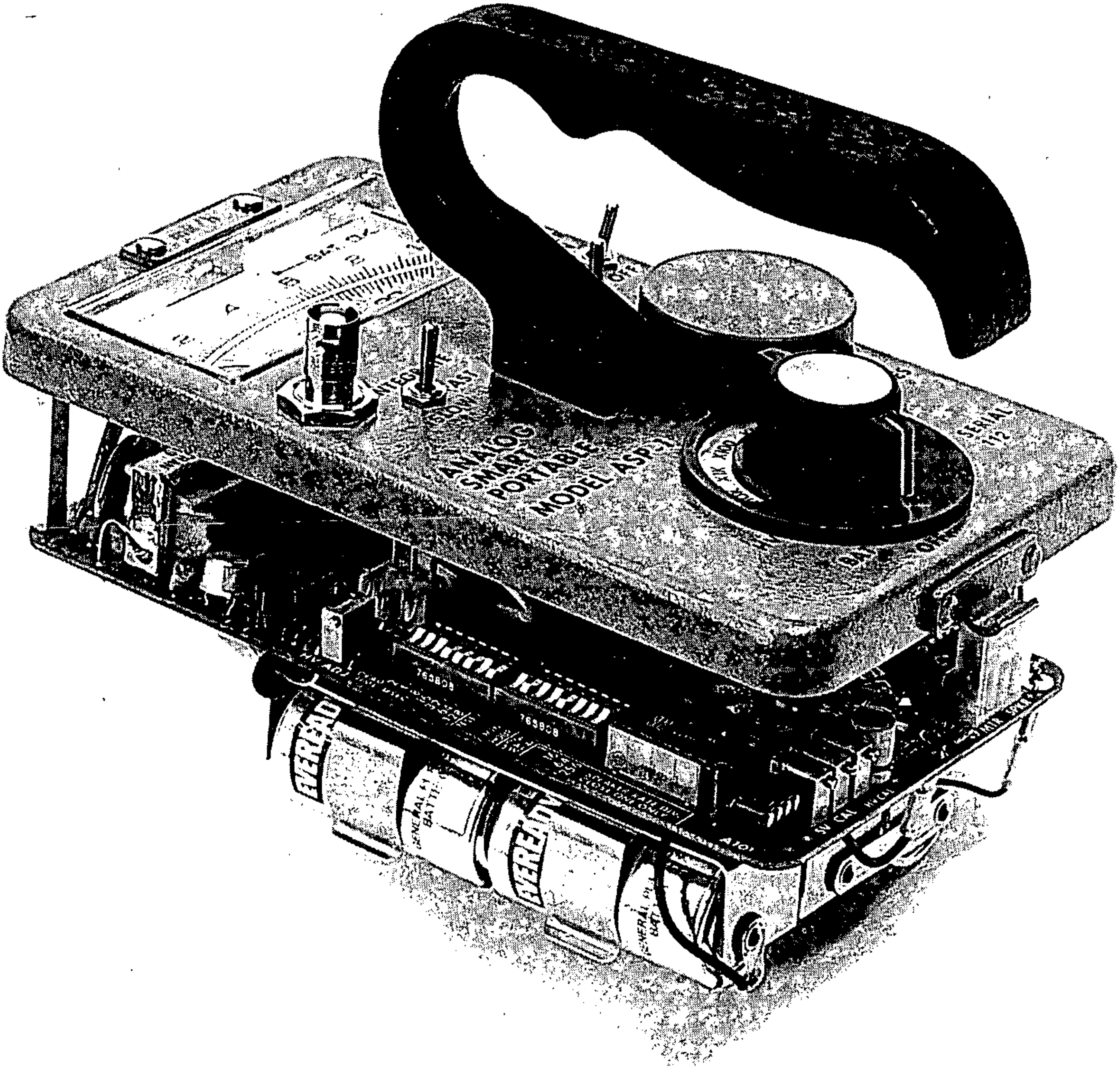


Figure 3-3. Internal View of Model ASP-1

SECTION IV
MAINTENANCE

WARNING

The high voltage power supply is capable of producing over 2500 volts and the energy stored in the filter capacitors may produce a hazardous shock. The voltage bleeds down slowly when the instrument is turned off.

CAUTION

The circuitry in the ASP-1 employs CMOS technology and is subject to damage from electrostatic discharge when the bottom can is removed. First, ground all equipment and components to the ASP-1 chassis or circuit common before touching the ASP-1 circuit components.

A. DISASSEMBLY

1. Set the range switch to the *OFF* position. Release the latches at both ends of the ASP-1 and remove the bottom can. The batteries can now be removed and should be removed if any further disassembly is to be done. (When re-installing the can, put the detector locating marks toward the front if the optional internal detector is installed).

2. To remove the battery pack, remove the batteries and disconnect the wires from the circuit board. Remove the four screws and lockwashers and lift off the pack.

3. To remove the optional PHA board (if installed), remove the screw holding it to the main board and remove it from its socket. If it is to remain out, a shorting header must be installed in the socket for the rest of the circuit to operate.

4. The main circuit board can be separated from the cover with the battery pack and optional PHA board in place, if desired. Unplug the meter and speaker connector from the board. If total separation is desired, unsolder the detector connector cable from the connector (or remove the connector mounting nut) and unscrew the nut holding the cable shield solder lug to the meter mount stud. Note which range switch multipliers are visible (for later re-installation) and remove the range switch knob, mounting nut, dial plate cover and dial plate. Remove the two screws at the front edge of the board and pull the board straight away from the cover.

When reinstalling the board assembly, align the pins of the toggle switches with the mating connectors and reverse the above procedures. The use of a small piece of transparent tape under the dial plate and dial cover, holding the two together in proper alignment, aids in reassembly.

To install a PHA circuit board, remove the shorting header from the PHA socket and insert the PHA board header into the socket. (If not already done, cut off and discard the two plastic projections on the receptacle under the speaker on-off switch.) Tighten the screw to hold the board in place.

B. PREVENTIVE MAINTENANCE

The ASP-1 should be kept as clean and dry as possible. No routine maintenance is required except for normal (owner specified) periodic recalibration. The batteries should be replaced when indicated by the battery check function. The batteries should be removed if the instrument is to be unused for an extended period of time.

C. CALIBRATION

1. Basic ASP-1

a. High Voltage Display:

1) If the internal detector option is installed, use a very high input impedance voltmeter (1000 M≤ or more) and measure the voltage on the high voltage standoff, relative to circuit ground. Adjust the *HV ADJ* control until the voltmeter reads 550 volts. Set the range switch to the *HV* position and adjust the *HV CAL* control until the lower scale of the ASP-1 meter reads 550 volts.

2) If no internal detector is installed, disconnect the external detector. Connect a very high input impedance voltmeter (1000 MΩ or more) to the high voltage standoff, relative to circuit ground. Adjust the *HV ADJ* control for a reading of 1500 volts on the voltmeter. Set the range switch to the *HV* position and adjust the *HV CAL* control until the ASP-1 meter shows 1500 volts. Adjust the *HV ADJ* control to a few other values across the meter face and compare the ASP-1 reading to the external voltmeter reading. The agreement should be within 50 volts plus any inaccuracy in the external voltmeter.

b. +5-volt Regulator: Connect an accurate voltmeter to pin 1 of A101 (or the circuit pad next to crystal X1), relative to circuit ground. (Or to edge connector pins M[+] and N[−]). Adjust the 5-volt control for a reading of plus 4.99 to 5.01 volts on the meter.

2. Calibration to Detectors

a. General

The ASP-1 is an extremely versatile instrument. It is usable with a wide variety of detectors and can be calibrated to accept a large selection of radiation units. The end result of the calibration process is the reading provided by the instrument. The accuracy of that reading depends on the accuracy achieved in the calibration process.

Properly set up and calibrated, the instrument is inherently linear and accurate because of its microcomuputer-based design. The only real limitation is the detector and its application in a particular measurement. For detector application information, see table 7-1.

A calibration record label is provided inside the ASP-1 can to preserve the calibration data. Its use is recommended for future reference. Also, it will facilitate interchanging detectors in the field.

b. Input Sensitivity Settings

Table 7-1 lists several Eberline detector models and gives typical calibration settings for each. The input sensitivity can nearly always be set as shown for all gross (not PHA) operations since the sensitivity is not critical. For detectors not listed, set the sensitivity according to detector type. (GM at 10 mV, proportional chambers at 1 mV, scintillators from 2 to 10 mV).

For all sensitivities between 1 and 15 mV, set the *GAIN* control fully clockwise for maximum gain. Connect a calibrated pulse generator (Eberline minipulser, typical), if available, to the detector connector and set the input sensitivity by adjusting the *THRESH* control. (If an internal detector is installed, connect the pulser to the Teflon® high voltage standoff). If a calibrated pulser is not available, table 4-1 may be used along with a voltmeter to set approximate input sensitivities. Measure the voltage between test connector pins N(−) (gnd.) and 12(+) (thresh.) and set the voltage shown for the sensitivity desired.

If the input sensitivity level is to be set at more than 15 mV (up to 50 mV maximum), a calibrated pulse generator (Eberline minipulser) or a pulser and an oscilloscope will be required. Connect the pulse generator to the detector connector and set the signal (negative) amplitude to the desired sensitivity level. Set the *THRESH* control fully clockwise and then adjust the *GAIN* control until the crossover point is located.

Conditions:
No PHA Installed
Gain Control (R128) maximum, fully clockwise

Voltage, Edge Connector Pins 12 to N	Nominal Input Sensitivity
+0.17	1
+0.33	2
+0.83	5
+1.67	10
+2.5	15

Conditions:
PHA Installed
Gain Control (R128) maximum, fully clockwise

Voltage, Edge Connector Pins 12 to 7	Nominal Input Sensitivity
−0.17	1
−0.33	2
−0.50	3
−0.67	4
−0.83	5
−1.00	6

Table 4-1. Input Sensitivity vs Reference Voltages

c. High Voltage Setting

WARNING

> The high voltage should be set to the nominal operating voltage or less (Ref: section VII) before connecting the detector to the ASP-1, to prevent damage to the detector. Check the high voltage by selecting the *HV* position on the range switch. (Make sure that calibration of the high voltage readout has been performed).

The bias (high voltage) operating point for a GM detector is fixed by its physical properties (i.e., size, counting gas, anode size, and fill pressure). Therefore, a check of its sensitivity, or efficiency, may preclude the plateau. It should be within ±20 percent of specified sensitivity at the specified operating voltage (see section VII).

To run a plateau, connect the detector to the ASP-1 with the cable to be used in operation. With the discriminator properly set, the plateau curve can be plotted. See figure 4-1.

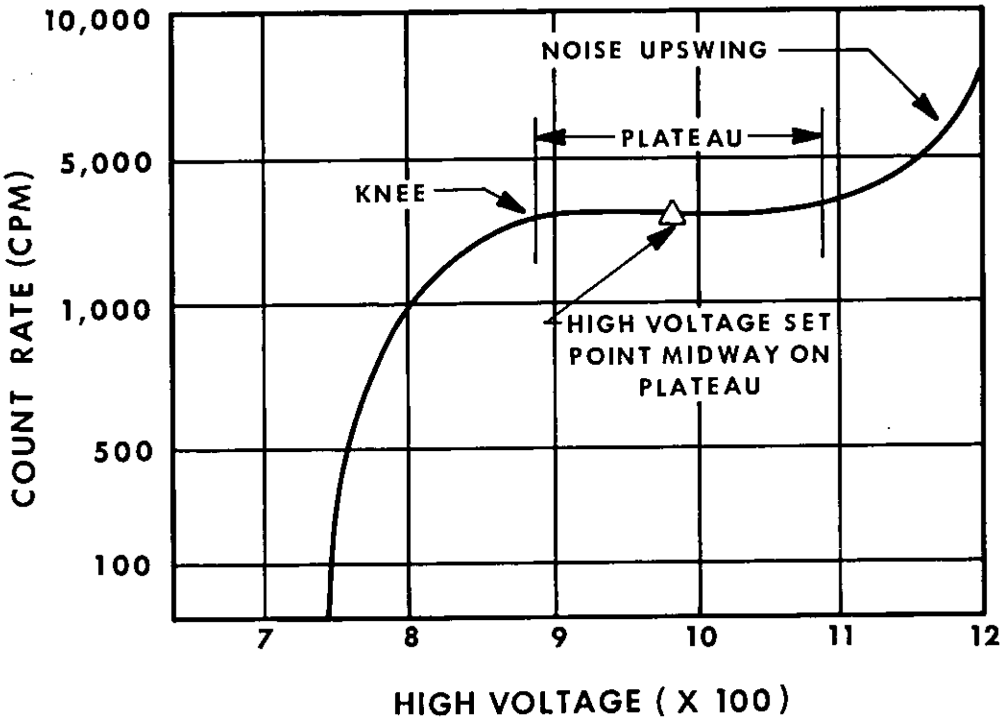


Figure 4-1. Typical Plateau Curve (11338-B25)

Although the units shown on the sample plateau curve are counts per minute, any other rate unit may be used to plot the graph.

To plot a plateau select *SLOW* or *FAST* on the response switch. Expose the detector to the source of radiation. The exposure rate is not too important. Select the *HV* position of the range switch and set the *HV ADJ* control for a low reading. Set the switch to the appropriate range and record the meter reading. Select *HV* again and increase the high voltage in 50- to 100-volt steps, recording the reading at each point. Allow enough time at each step for the reading to stabilize. Plot the plateau curve and set the high voltage accordingly.

An alternate, less formal method of determining the plateau location, consists of the following. Connect the detector and expose it to the radiation source. Set the range switch to an appropriate multiplier position and slowly bring the high voltage up until a plateau region is found. Adjust the high voltage until the low end of the plateau is found. Switch to the *HV* position and record the high voltage. Switch back to the multiplier position and carefully bring up the high voltage until the upper end of the plateau is found. Switch to *HV* and record the voltage. Compare the two high voltage values and select an operating point.

d. Setup and Calibration Procedure, any Detector

If simple recalibration is to be performed, omit this paragraph and go on to paragraph C.2.e. If the detector chosen is listed in table 7-1, set up the ASP-1 according to the table and go on to paragraph C.2.e.

1) Select the desired radiation rate units for the detector (mR/h, μSv/min, cpm, cps, rem/h, etc.).

2) Determine the detector sensitivity in cpm per rate unit (cpm/μSv/min, cpm/mR/h, cpm/cps [60], cpm/cpm [1], etc.).

3) Adjust the range switch multiplier dial so that the lowest multiplier visible is as follows. (To set the dial, see paragraphs in A.4 of this section.)

Detector Sensitivity, cpm/Rate Unit	**Lowest Visible Multiplier**
.21 to 2.1	X100
2.1 to 21	X10
21 to 210	X1
210 to 2100	X.1
2100 to 21,000	X.01
21,000 to 210,000	X.001

4) Install the selected rate unit label in the holder just forward of the meter. If a PHA circuit board was installed, include a "PHA INSTALLED" label. A sheet of typical labels is included in this manual.

5) If desired, precalibrate the *CAL* switches and *CAL* potentiometer settings as follows:

Take the detector sensitivity value, cpm/rate unit (from step d.2 immediately preceeding) and move the decimal point to get a number (call it "x") between 21 and 210.

If x is between	**Set Calibration Switches**		**Nominal "Standard" Current Indication Equals:**
	3	**4**	
21 and 36	closed	closed	15.6 divided by x
36 and 65	open	closed	27.7 divided by x
65 and 114	closed	open	49.2 divided by x
114 and 210	open	open	87.5 divided by x

("Standard" current is obtained by selecting *FAST* or *SLOW*, selecting a multiplier position of the range switch and pressing the *RESET* switch for five seconds or more. After setting the *CAL* switches as indicated, produce the standard current and use the *CAL* potentiometer to obtain the calculated value. The standard current reading must never be less than .42.)

e. Calibration to Exposure Rate

The following procedure assumes simple recalibration. That is, the rate units above the meter, the multipliers showing under the range switch and the detector in use are all compatible.

1) Expose the detector to a moderately low radiation rate. (Consideration should be given to the background radiation rate if the exposure rate is a low value. Table 7-1 gives recommended calibration exposures for some standard Eberline detectors.)

2) Set the range switch to the appropriate range.

3) Set both *CAL SW 3* and *CAL SW 4* switches to *OPEN*. Attempt to set the meter reading to the detector exposure rate by adjusting the *CAL* control. If the reading remains too low when the *CAL* control is fully clockwise, bring in the *CAL* switches in the following order until the reading is at or above the exposure amount. Then, adjust the *CAL* control for the proper reading.

CAL SW closing order:

SW 3 CLOSED, SW 4 OPEN (multiplying factor, 1.78)
SW 3 OPEN, SW 4 CLOSED (multiplying factor, 3.15)
SW 3 CLOSED, SW 4 CLOSED (multiplying factor, 5.6)

4) Expose the detector to a relatively high field where the dead-time losses are significant. (Table 7-1 gives recommended high exposure rates for some standard Eberline detectors.) Set the *DEAD-TIME* switches so that the meter reads the high exposure rate. (The nominal dead times of some standard Eberline detectors, when used with the ASP-1, are also shown in table 7-1.) The *DEAD-TIME* switch values are additive (when closed) which permits the setting of any value from 0 to 254 µs in steps of 2 µs. (The computer always adds one µs to the values on the switches, so the dead-time values used in the computation range from 1 to 255 in steps of two.)

5) Perform a linearity check at various exposure rates from a low rate up to where the overrange alarm is given. (Overrange occurs at a precomputed count rate, based on the settings of the dead-time switches, or at a times 5 dead-time correction factor.) The ASP-1 must be turned *OFF* and back on to reset the overrange alarm. If desired, reset the *DEAD-TIME* switches to average out points where the meter reading is above and below the nominal value.

6) If radiation exposures sufficiently high enough to do steps 4 and 5 above are not available, set the dead-time switches to the nominal amount given for the detector.

7) When the rate function is fully calibrated, the setting of the "per unit time" switches fully calibrates the integrate function. If the rate unit of time is "per hour", close the *HOUR* switch and open the *MIN* switch. If it is "per minute", close the *MIN* switch and open the *HOUR* switch. If the calibration is in "per second", open both of the time switches. The computer defaults to per second if both switches are open. No time units other

than hour, minute and second are permissible for the integrate function.

8) Select *FAST* or *SLOW*, set the range switch to any multiplier position and hold *RESET* for five seconds. Observe and record the "standard" current reading for the present calibration setup. (The standard current value must not be less than .42.)

f. Set the *SPEAKER RATE DIV* switches as desired to get the most value from the speaker sound under typical use conditions. Close one switch only. Closing more than one switch may stop the detector clicks from the speaker but will not effect any other ASP-1 operation.

g. Calibration Summary

1) Set the input sensitivity with the *THRESH* and *GAIN* controls.

2) Set the high voltage with the *HV ADJ* control.

3) Set the *CAL* switches and *CAL* control at a low exposure rate.

4) Set the *DEAD-TIME* switches at a high exposure rate.

5) Set the "per unit time" switches.

6) Set the *SPEAKER RATE DIV* switches.

7) Confirm or revise the data on the calibration label on the ASP-1 can.

h. Calibration with PHA

To utilize the pulse-height analyzer (PHA) function, the amplitude of the detector pulses must be proportional to the energy of the radiation and must vary with the high voltage applied.

To install a PHA circuit board, remove the shorting header from the PHA socket and insert the PHA board header into the socket. (If not already done, cut off and discard the two plastic projections on the receptacle under the speaker on-off switch.) Tighten the screw to hold the board in place.

The most reasonable readout units for PHA operation are counts per unit time (cpm, cps, etc.) since the detector is producing pulses from other energies which are not being counted. However, the PHA circuit operation is the same, regardless of the readout units chosen. A review of the PHA circuit description and terms used in the "Theory of Operation" section may be helpful. The adjustment of the window width, relative to the threshold setting, is always a compromise. Refer to the curves of figure 4-2. In each case, the narrower window results in a sharper peak (better exclusion of adjacent energies), but the count rate is lower and the peak may be harder to find. Experimentation using the particular detector and a check source of the isotope of interest will help select the best percent window for your application. In general, a window between 25 percent to 100 percent of the threshold level is reasonable.

When PHA is in use, the overrange alarm function and the dead time correction function will probably be ineffective because the PHA circuit rejects many of the incoming pulses, and the computer does not sense the high count rate.

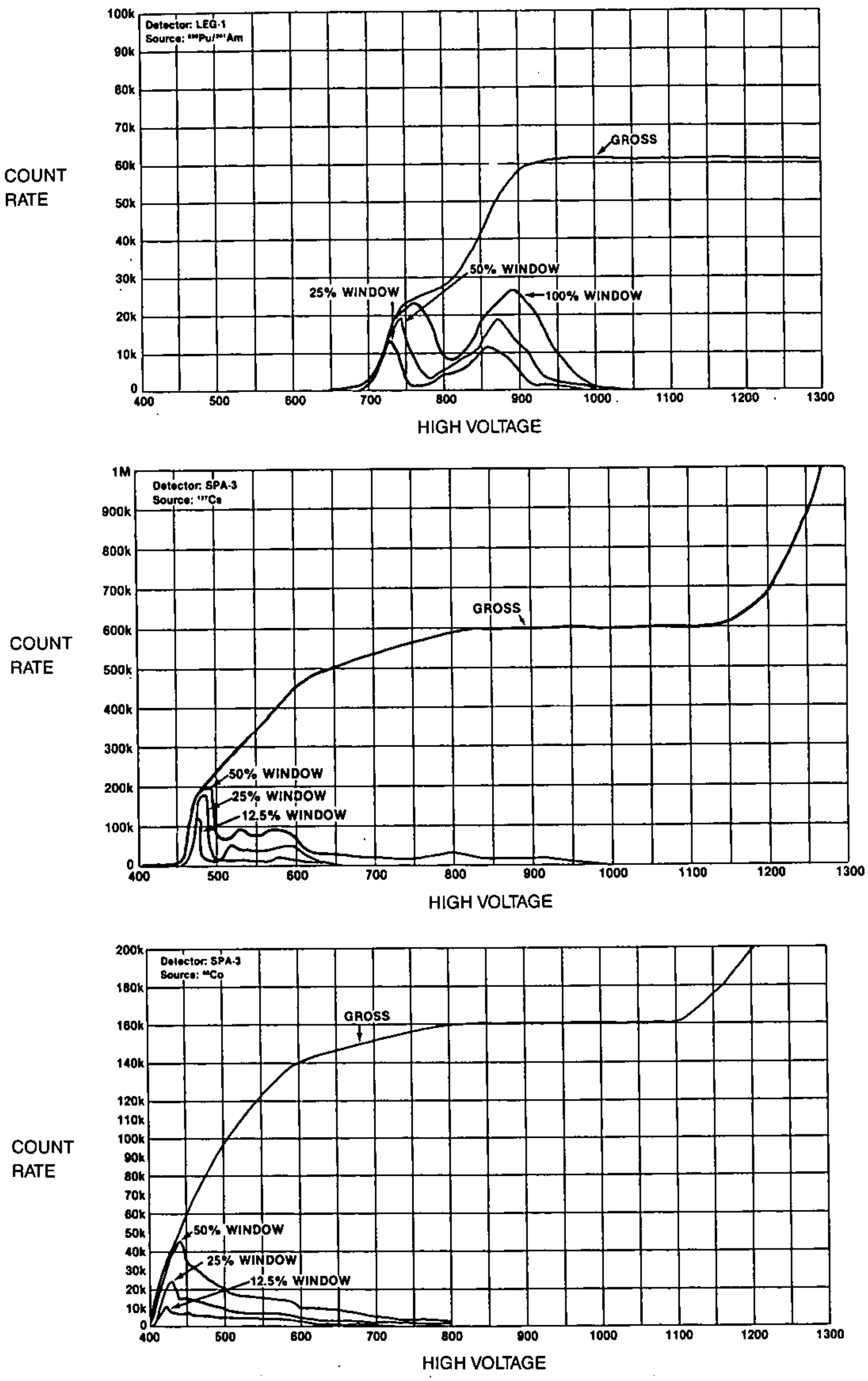


Figure 4-2. Typical PHA Operating Curves

The following gives examples of various methods of setting the threshold and window controls.

Method 1. No test equipment required.

1. Set the *GAIN* control fully clockwise, maximum gain.
2. Set the *THRESH* control fully clockwise, least sensitivity. This will result in about 6 mV input sensitivity.
3. Set the *WIN* control fully clockwise, widest window. This will set the window about 6 mV wide, a 100 percent window. (For a 50 percent window, set the *WIN* control midway between the end points [count the turns.])
4. Set the *PHA-GROSS* switch to *PHA*.
5. Expose the detector to the isotope of interest and adjust the high voltage until the energy peak lies in the window, indicated by a decrease in reading when the high voltage is adjusted either way. Remove the source to verify that the proper peak was found.
6. Check the *GROSS* position. The reading will increase if energies above the window setting are present at the detector. Reset to *PHA* for PHA operation.

Method 2. Voltmeter method.

1. Set the *GAIN* control fully clockwise, maximum gain.
2. Set the *THRESH* control fully clockwise, least sensitivity.
3. Connect the reference lead of a voltmeter to pin 3 of the PHA socket (pin 7 of the test-edge connector).
4. Measure the voltage at pin 16 of the PHA socket (pin 12 of the test-edge connector). It will be approximately 1 V negative with respect to the reference lead.
5. Connect the voltmeter lead to pin 13 of the PHA socket (pin 11 of the test edge connector). Adjust the *WIN* control for a positive voltage equivalent to the percent window desired. For a 25 percent window, make this voltage one-quarter as large as that found in step 4, and so forth.
6. Set the *PHA-GROSS* switch to *PHA*.
7. Expose the detector to the isotope of interest and adjust the high voltage until the energy peak is in the window. Remove the source to verify that the proper peak was found.
8. Check the *PHA-GROSS* switch operation. Return to *PHA* for PHA operation.

Method 3. Pulser Usage

A calibrated pulser could have taken the place of the voltmeter in method 2 (immediately preceding). Instead of measuring the threshold and window voltages, the pulser, connected to the detector connector, could have been used to establish the desired signal levels and the *THRESH* and *WIN* controls set accordingly. For example, if the threshold was found at 6 mV, the pulser could have then been set for 9 mV, and the *WIN* control adjusted for crossover. The window would then have been at 50 percent (threshold 6, window width 3.)

This next procedure uses the pulser to set up the PHA circuit to correspond to actual energy levels. Once set, a voltmeter can be used to select a different specific energy.

1. Connect the calibrated pulser (Eberline Minipulser, for example) to the detector connector.
2. Set the pulser for 10 mV output, between 2k to 20k cpm.
3. Set the *PHA-GROSS* switch to *GROSS*.
4. Set the *THRESH* control fully clockwise, minimum sensitivity.
5. Adjust the gain control until the crossover point is located.
6. Set the *PHA-GROSS* to *PHA*.
7. Set the pulser for 12 mV.
8. Adjust the *WIN* control until crossover is located.
9. Set the pulser at 5.6 mV output.
10. Set the *PHA-GROSS* switch to *GROSS*.
11. Adjust the *THRESH* control until the crossover point is located.
12. Remove the pulser and connect the detector to be used.

13. Select PHA

14. Expose the detector to a ^{137}Cs source and adjust the high voltage until the cesium peak (660 keV) is in the window. Remove the source to help make sure the proper peak was found.

As now set up, the nominal span of the threshold and window controls is from zero to 1 MeV, corresponding to zero to one volt as measured on the *THRESH* and *WIN* lines, referenced to the *PHA REF* line. (For measurement points, see method 2 above.) A voltmeter can now be used to set new specific energies for the threshold and window widths. Remember, the peak is centered in the window, which is one-half a window width above the threshold setting.

If, in step 9 the pulser had been set at 2.3 mV instead of 5.6 mV, the nominal calibration would have been from zero to 2 MeV for the spans, instead of zero to 1 MeV. An alternate method to obtain zero to 2 MeV is to use ^{60}Co (1.25 MeV, average of two peaks) instead of ^{137}Cs and set the pulser at 5.25 mV in step 9.

In all cases where possible, the isotope of interest should be used to make the final setup adjustment to make sure the energy is peaked in the window.

D. TROUBLESHOOTING

The primary troubleshooting aid is a thorough understanding of the circuit functions. Section III, "Theory of Operation"; figure 3-1, the block diagram; and figure 6-1, the general schematic, are the primary aids to this understanding.

The following table provides some possible solutions to specific symptoms.

NO.	SYMPTOM	POSSIBLE FAULT	POSSIBLE SOLUTIONS
1	Battery okay, instrument totally dead, +5 V line is low.	+5 V regulator bad	Replace A101
		Heavy load on +5 V line	Replace faulty component
		R15, +5 V adjust potentiometer open	Replace R15
2	Maximum output from high voltage circuit is too low.	+5 V line low	Reset R15 for 5 V from A101
3	High voltage okay, no meter indication of high voltage.	A102 amplifier 5-6-7 inoperative	Replace A102
		R104 or R105 open	Replace bad resistor
		S1 high voltage contact bad	Replace S1
4	High voltage output is at maximum. High voltage adjust potentiometer has no control.	R12 open, tap to high voltage line	Replace R12
		A102 faulty	Replace A102
		R17 ground lead open	Replace R17
		Q103 shorted	Replace Q103
5	High voltage output is zero. High voltage adjust potentiometer has no control.	A102 faulty	Replace A102
		Q103 open	Replace Q103
		Q10 faulty	Replace Q10
		T1 faulty	Replace T1
		HV diode CR10, 11, 12 open	Replace diode
6	High voltage output and "standard" meter current unstable.	+5 V line unstable	Replace A101
		Erratic excessive load on +5 V	Replace faulty component

NO.	SYMPTOM	POSSIBLE FAULT	POSSIBLE SOLUTIONS
7	High voltage output unstable.	High voltage leakage or component breakdown	Check detector and detector cable. Clean HV components and circuit board. Clean MHV connector. Check location of shield on R12. Replace faulty component.
8	High voltage okay, +5 V okay, "standard" current okay, no speaker click, no count rate showing on the meter.	No signal through the amplifier and discriminator	
		Bad detector	Replace detector
		Open detector cable	Replace cable
		Amplifier IC or Q106 bad	Replace A103 or Q106
		Nothing plugged into PHA socket	Plug in PHA board or shorting header
9	High voltage okay, +5 V okay, "standard" current okay. No meter count rate, speaker clicks okay on divide-by-1 countdown only.	A105 bad	Replace A105
10	Speaker only dead	Bad speaker	Replace SK1
		Q11 or Q12 or A104 bad	Replace bad component
		More than one speaker rate divider switch closed	Close one switch only
11	Meter lamps inoperative	Either lamp open	Replace lamp
		S4 lead missed the connector	Reassemble S4 properly
12	Speaker okay, high voltage okay, meter never comes off zero, any position of S1.	Open meter winding	Replace meter
		Bad contact on S1	Replace S1
		Bad contact in P2	Replace contact
13	Speaker *ON/OFF* inoperative or *LIGHT-RESET* inoperative or *INTEGRATE-FAST-SLOW* inoperative	Switch leads missing mating sockets	Reassemble properly
14	High voltage output and +5 V okay but meter and speaker dead.	P2 not plugged in	Plug in P2
15	Battery okay, high voltage okay, speaker okay, ASP-1 inoperative on all range multiplier positions.	Test switch not closed	Close test switch, set ASP-1 off and back on.
		D/A, A4 bad	Replace A4
		R6, *CAL*, set fully counterclockwise	Set R6 properly
		A1, A2, A3 or X1 bad	Replace faulty component
		C2 bad	Replace C2
16	+5 V okay, cannot reach full scale on any range switch position, rate or integrate.	Improper calibration setup of *CAL* switches 3 and 4 and *CAL* potentiometer	Review calibration procedure and recalibrate. Always use minimum *CAL* switch boost possible.
		A4 bad	Replace A4

NO.	SYMPTOM	POSSIBLE FAULT	POSSIBLE SOLUTIONS
17	Meter falls backward on otherwise smooth integration increase.	A4 bad	Replace A4
18	Meter oscillates on integration position.	Both time switches closed	Close one or none only. See calibration procedures.
19	High count rate occurs constantly, both speaker and meter.	Bad detector or cable	Replace faulty unit
		Threshold control fully counterclockwise	Reset threshold potentiometer
		High voltage set too high	Reset properly
		High voltage arcing	See solution no. 7
20	Range multiplier positions, *DEAD-TIME* switches or *CAL* switches apparently inoperative.	A5 or A6 multiplexer bad	Replace A5 or A6
21	Meter will not adjust to the full value.	R6 is the wrong value. R6 is 5k and needs to be 20k to drive the new rugged meter.	Replace R6 so it is a 20k ohm pot.

SECTION V
PARTS LIST

The following table lists the electronic items incorporated in the ASP-1 and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
1. Basic ASP-1				
J1	Connector	MHV Receptacle	Amphenol 27025	CXMH2
M1	Meter	200μA	Modutec 1-130-068B	MTPA37
	Units Label Cover	Clear Plastic		ZP11338013
P2	Connector	Housing, 4-place	Molex 09-50-7041	COMR104
	Contacts	Sockets for P2	Molex 08-50-0106	COHD11
S2	Toggle Switch	3-Position, Center Off	CK 7103-S-D-W5-B-E	SWTO29
S3	Toggle Switch	SPDT	CK 7101-S-D-W5-G-E	SWTO30
S4	Toggle Switch	3-Position, Spring-Loaded to Center (Off)	CK 7105-S-D-W5-B-E	SWTO31
SK1	Speaker	1-inch-diameter × 0.6-inch-deep, 8Ω		ADSP4
	Speaker Retainer			ZP11338004
	Battery	1.5 V, "C" cell, C-Zn		BTCZ6
	Battery Holder			BTBH10
	Receptacle	For Battery Connection	Faston 61060-1	TEQC2
	Can Assembly			YP11338002
	Handle			ZP10434041
	Knob	For Range Switch	Rogan RB-67-2-B-M	HDKN25
	Dial Plate	Switch Multiplier Plate		ZP11338006
	Dial Plate Cover			ZP11338007
	Headset	Acoustic Air Tube Type		ADHS4
2. Main P.C. Board, part no. YP11339000				
A1 (note 1)	Integrated Circuit	Microprocessor	Intel 80C51	ICXXASP1
A3	Integrated Circuit	Octal Buffer	National 74HC373 or 54HC373J	ICHCA74373
A4	Integrated Circuit	Digital-to-Analog	Analog Devices AD7524 or PMI PM7524HP	ICCMA07524
A5, A6	Integrated Circuit	Multiplexer	RCA CD74HC157	ICCMAHC157

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
A101	Integrated Circuit	Regulator	Intersil ICL7663CPA	ICAVA7663C
A102	Integrated Circuit	Operational Amplifier	Motorola MC14573	ICAOA14573
A103	Integrated Circuit	Operational Amplifier	Motorola 14575	ICAOA14575
A104	Integrated Circuit	Quad 2-input NOR Gate	RCA 4001B	ICCMA4001B
A105	Integrated Circuit	12-Bit Binary Counter	RCA CD4040B or SGS HFC4040BE	ICCMA4040B
C1, C104, C107	Capacitor	0.1 μF, 10%, 50 V	Centralab CW20C104K	CPCE104P3N
C2, C109	Capacitor	10.0 μF, 20%, 16 V, Tantalum	Sprague 199D106X0016CB1 or ITT TAP-B10K35	CPTA100M4X
C4, C10	Capacitor	33.0 μF, 10%, 10 V, Tantalum	Sprague 199D336X9010	CPXX12
C8	Capacitor	0.047 μF, 20%, 50 V	Sprague 1C25Z5U	CPCE473P4N
C11	Capacitor	220 pF, 20%, 3 kV	CAPCO EBL2	CPPF221P4Y
C12, C13	Capacitor	0.01 μF, 20%, 3 kV	Sprague 30GA-S10 or Centralab DD30-103	CPCE103P4Y
C14	Capacitor	0.047 μF, 10%, 4.0kV	CAPCO EBL1	CPPF503PXY
C15	Capacitor	0.001 μF, 10%, 3 kV	Centralab DD30-102	CPCE102P3Y
C16	Capacitor	0.27 μF, 20%, 50 V	Centralab CW30C274M	CPCE274P4N
C17, C102, C114	Capacitor	1.0 μF, 10%, 35 V, Tantalum	Sprague 199D105X9035	CPXX11
C101	Capacitor	220.0 μF, 20%, 10 V, Tantalum	Sprague 503D	CPAL221M4F
C110	Capacitor	820.0 pF, 10% or 20%, 100 V	Erie CK12BX821K	CPCE821P3P
C111, C115	Capacitor	100 pF, 10%, 50 V	AVX SP155A101KAA	CPCE101P3N
C112	Capacitor	0.022 μF, 10%, 100V	Kemet C062C223K1X1CA	CPCE223P3P
C113	Capacitor	1000.0 pF, 10%, 100 V	Centralab CN20A102K	CPCE102P3P
CR10, CR11, CR12	Diode	Silicon, 2.5 kV, PIV	Varo VA25	CRSIVA0025
CR101, CR102, CR103, CR105	Diode	Silicon, Switching	1N4148	CRSI1N4148
CR106	Diode	Schottky	Motorola MBR130P	CRSCMBR130
DS1, DS2	Bulb	5 V, 21 mA, incandescent	Type No. 2	LPBU13
J2	Receptacle	4-pin	Molex 09-60-1041	COMR304
J4, J5, J6	Receptacle	3-Socket	Molex 09-52-3033	COMR1003
Q10	Transistor	PNP, Silicon	Motorola 2N4234 or National 2N4234, 2N4236	TRSP2N4234
Q11, Q12, Q103	Transistor	NPN, Silicon	2N4401	TRSN2N4401
Q106	Transistor	NPN, Silicon	2N5088	TRSN2N5088

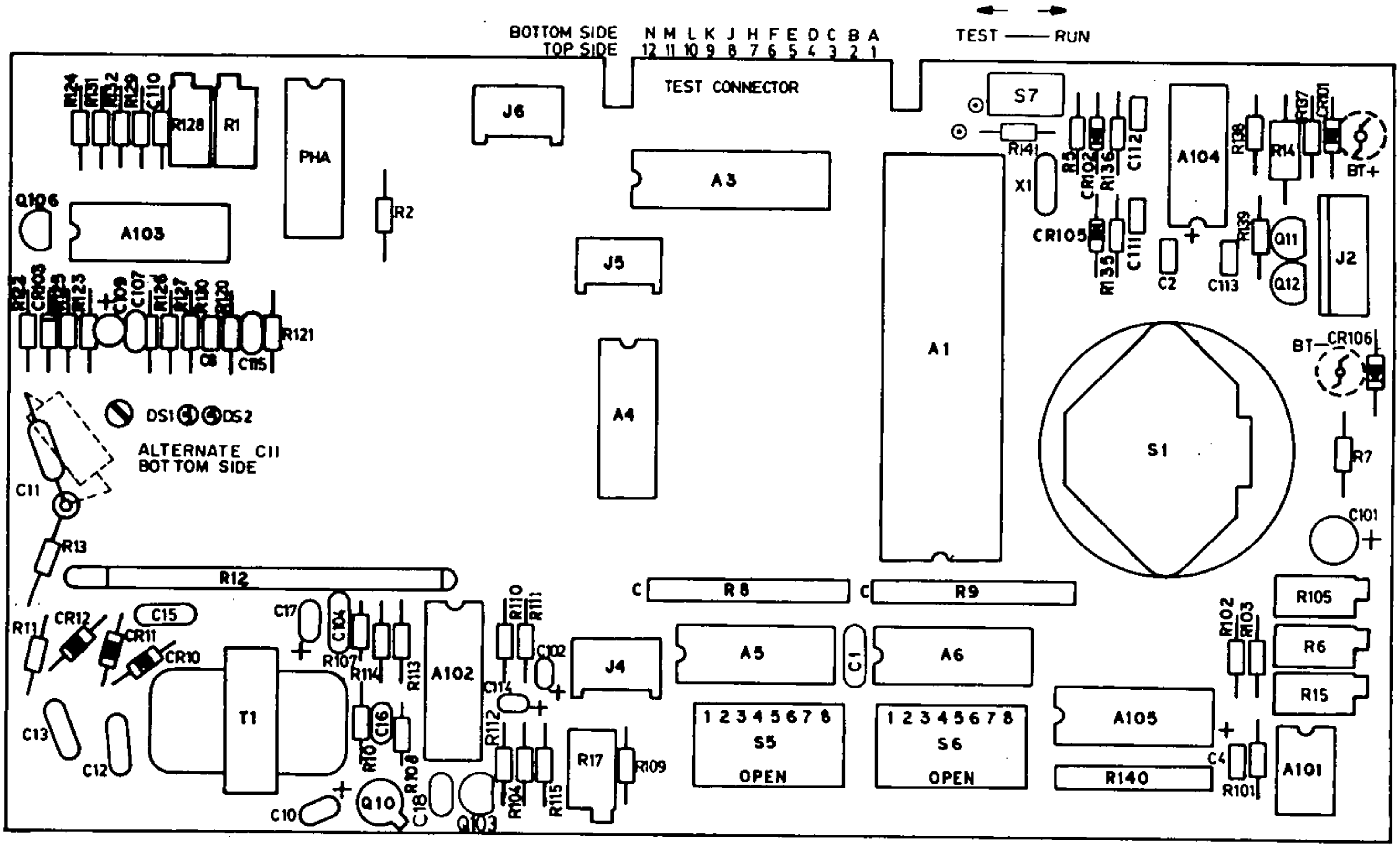
REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
R1	Potentiometer	10k	Spectrol 64X103	PTCE103B93
R2, R104	Resistor	10k, 1%, 1/4 W	RN55D	RECE103B12
R5, R115, R137	Resistor	510k, 5%, 1/8 W, Carbon Composition		RECC514B21
R6	Potentiometer	20k, 1/2 W	Spectrol 64X203	PTCE203BA3
R7	Resistor	49.9k, 1%, 1/4 W	RN55D	RECE493B12
R8, R9	Resistor Array	470k, 2%, 1/8 W, ea. 9 Res, 1 comm.	A-B 110A474	REAR474B21
R10	Resistor	270 Ω, 5%, 1/4 W, Carbon Composition		RECC271B22
R11	Resistor	10M, 5%, 1/4 W, Carbon Composition		RECC106B22
R12	Resistor/Div.	1000M/1M, 10%	TRW/IRC 76-99-00K-00-044-2507	REXX22
R13	Resistor	100k, 1%, 1/4 W	RN55D	RECE104B12
R14	Resistor	22 Ω, 5%, 1/2 W, Carbon Composition		RECC220B23
R15, R128	Potentiometer	100k	Spectrol 64X104	PTCE104B83
R17	Potentiometer	50k	Spectrol 64X503	PTCE503B33
R101	Resistor	2.7 Ω, 5%, 1/8 W, Carbon Composition		RECC271N21
R102	Resistor	1M, 1%, 1/4 W	RN55D	RECE105B12
R103	Resistor	301k, 1%, 1/4 W	RN55D	RECE304B12
R105	Potentiometer	5k	Spectrol 64X502	PTCE502B53
R107	Resistor	100 Ω, 5%, 1/8 W, Carbon Composition		RECC101B21
R108, R110	Resistor	30k, 5%, 1/8 W, Carbon Composition		RECC303B21
R109	Resistor	44.2k, 1%, 1/4 W	RN55D	RECE443B12
R111, R120, R121 R123, R127	Resistor	20k, 1%, 1/4 W	RN55D	RECE203B12
R112	Resistor	470 Ω, 5%, 1/8 W, Carbon Composition		RECC471B21
R113	Resistor	1k, 5%, 1/8 W, Carbon Composition		RECC102B21
R114	Resistor	62k, 5%, 1/8 W, Carbon Composition		RECC623B21
R122, R125	Resistor	2.1k, 1%, 1/4 W	RN55D	RECE212B12
R124	Resistor	68.1k, 1%, 1/4 W	RN55D	RECE683B12
R126, R129, R130	Resistor	150k, 1%, 1/4 W	RN55D	RECE154B12
R131, R132	Resistor	200k, 5%, 1/8 W, Carbon Composition		RECC204B21
R135	Resistor	100k, 1%, 1/10 W	RN50	RECE104B11
R136	Resistor	75k, 5%, 1/8 W, Carbon Composition		RECC753B21
R138	Resistor	270k, 5%, 1/8 W, Carbon Composition		RECC274B21

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
R139	Resistor	3.3k, 5%, 1/8 W, Carbon Composition		RECC332B21
R140	Resistor Array	4.7k, 2%, 1/8 W, ea. 4 Indiv. Res	A-B 108B472	REAR472B12
S1	Rotary Switch	DWG 11338-B12		SWRO51
S5, S6	8-Dip Package	Rockers, SPST	Grayhill 76SB08	SWM15
T1	Transformer	Blocking Oscillator	Microtran M8149	TFHV5
X1	Crystal	6.0 MHz, 0.015%	MP-060	CYOS9
	Connector Tab	For Batteries	AMP 61134-1	TEQC3
	Header	For PHA Socket	Aries 16-675-191	MECO4
	Cover	For PHA Header	Aries 16-650-10	MECO5
3. Optional PHA P.C. Board, part no. YP11340000				
A106	Integrated Circuit	Quad Comparator	National LM339N	ICACA0339N
A107	Integrated Circuit	Dual BCD Counter	RCA CD4518BE	ICCMA4518B
C31	Capacitor	0.1 µF, 10%, 50 V	Centralab CW20C104K	CPCE104P3N
C32	Capacitor	150 pF, 10%, 1 kV	Centralab DD-151	CPCE151P3U
C33	Capacitor	33 µF, 10%, 10 V, Tantalum	Sprague 199D336X9010	CPXX12
C34	Capacitor	1 µF, 10%, 35 V	Sprague 199D105X9035	CPXX11
C35	Capacitor	150 pF, 10%, 50 V	AVX SR155A151KAA	CPCE151P3N
CR31, CR32, CR33	Diode	Silicon Switching	1N4148	CRSI1N4148
R31, R33	Resistor	10k, 1%, 1/4 W	RN55D	RECE103B12
R32	Potentiometer	10k	Spectrol 64X103	PTCE103B93
R34, R36	Resistor	20k, 1%, 1/4 W	RN55D	RECE203B12
R35, R37, R40	Resistor	2.1k, 1%, 1/4 W	RN55D	RECE212B12
R38	Resistor	27k, 5%, 1/8 W, Carbon Composition		RECC273B21
R39	Resistor	15k, 5%, 1/8 W, Carbon Composition		RECC153B21
R41	Resistor	470k, 5%, 1/4 W, Carbon Composition		RECC474B22
R42	Resistor	220, 5%, 1/8 W		RECC221B21
S31	Slide Switch	SPDT	Alcoswitch SSA-12	SWSL8
	Header	16 pin-to-pin	SAMTEC AP-316-G-A	MECO8

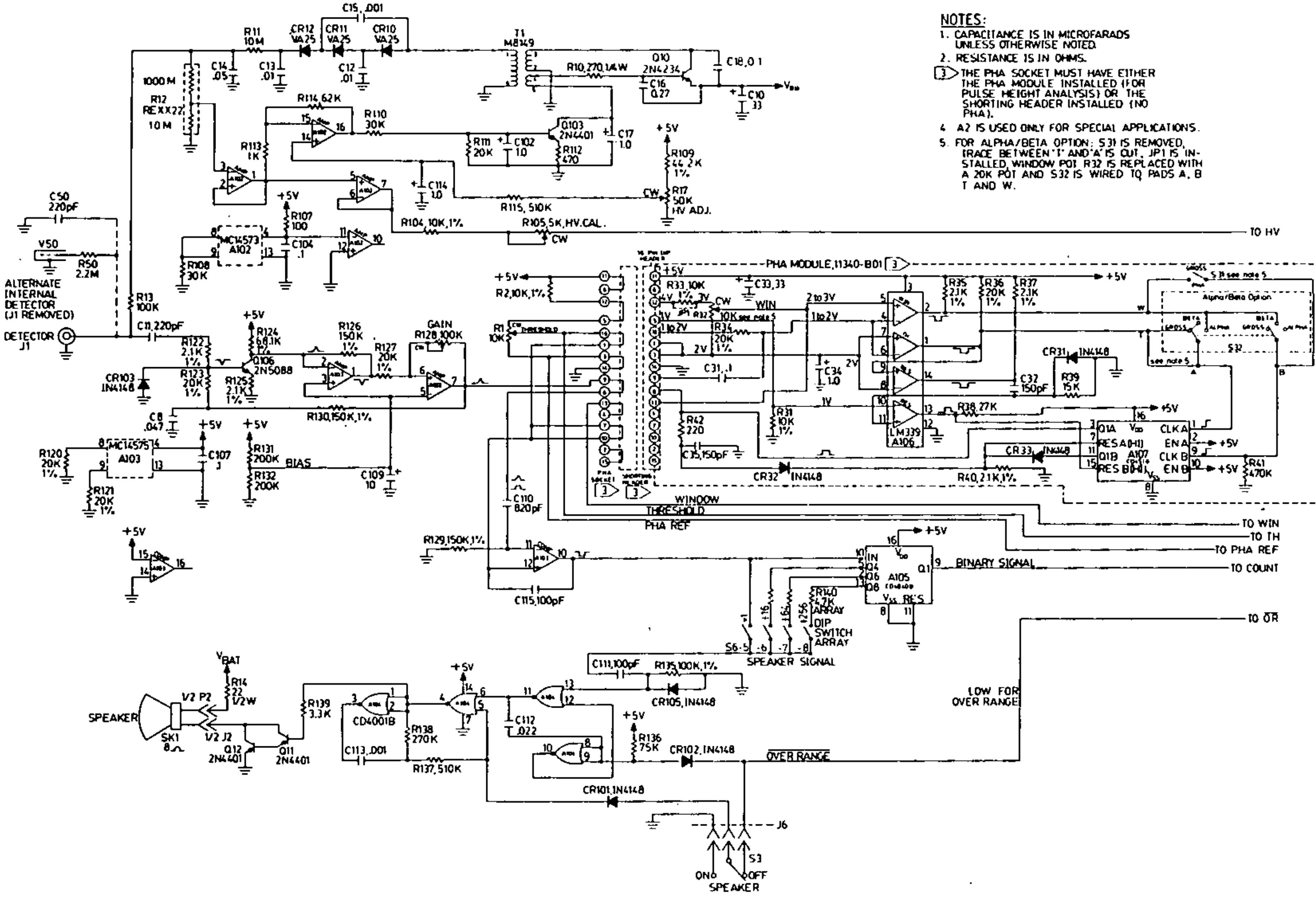
REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
4. Internal Detector Option, part no. YX11339002				
V50	GM Tube	DWG 10450-B28	LND 71412	TUGM5
R50	Resistor	2.2M, 5%, 1/4 W, Carbon Composition		RECC225B22
C50, C11	Capacitor	220 pF, 10%, 3 kV	Centralab DD30-221	CPCE221P3Y
	Hole Plug	1/2-inch-diameter, black plastic		MMBZ16
	Clip	Plastic		MMCL19
	Washer	5/8-inch-o.d. × 0.116-inch-i.d.		SCMW30

Notes

1. A recent change to the ASP-1 has been made to make use of a masked ROM/CPU integrated circuit chip combination (ROM is read only memory and CPU is central processing unit). This single chip replaces two integrated circuit chips, the CPU and the EPROM (EPROM is erasable programmable read only memory). Any reference to A2 and its functions should now be A1. Address latch A3 remains in the circuit but performs no function.

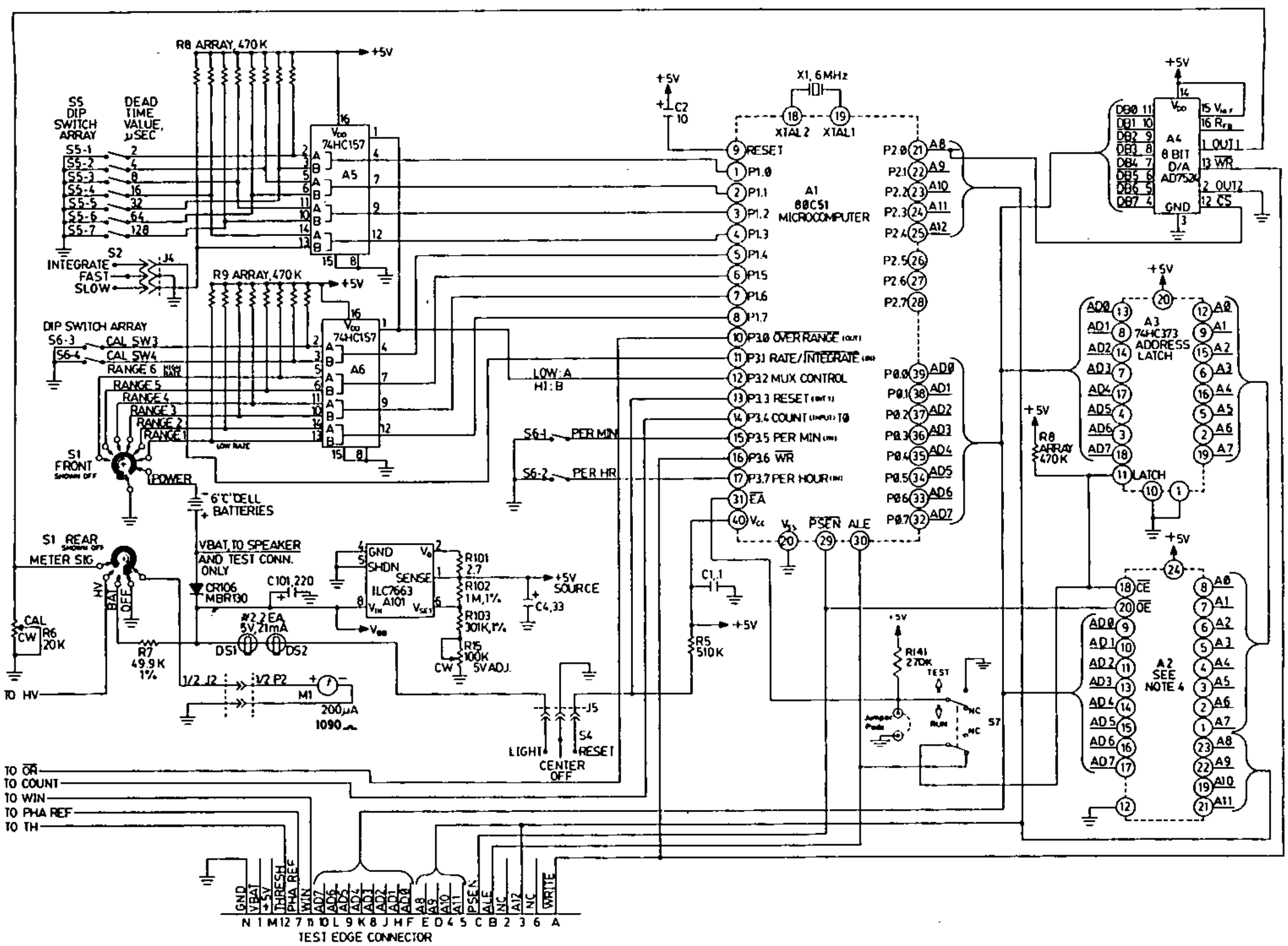


ASP-1 Main PCB Assy (11339-C03^{D})



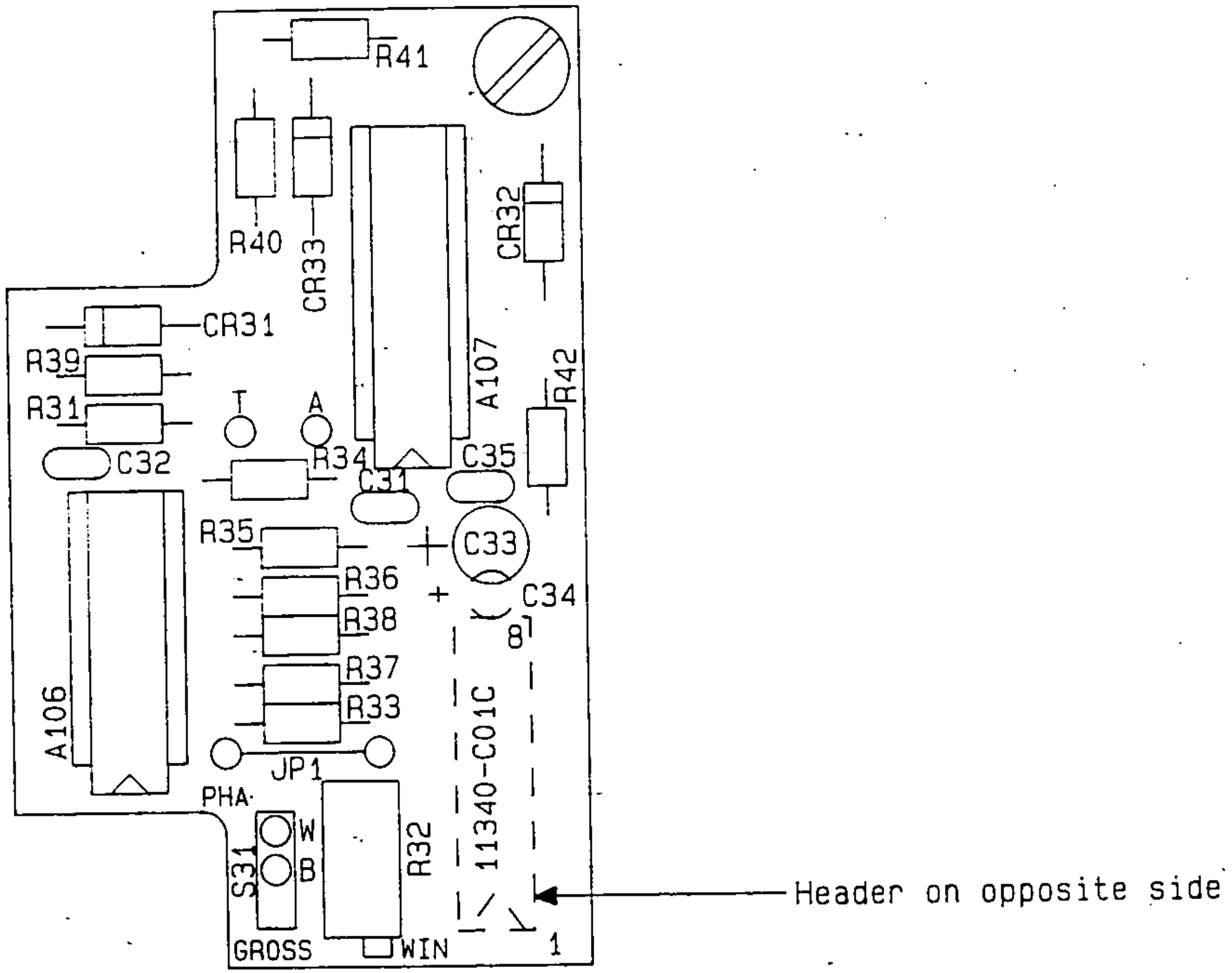
NOTES:
1. CAPACITANCE IS IN MICROFARADS UNLESS OTHERWISE NOTED.
2. RESISTANCE IS IN OHMS.
3 THE PHA SOCKET MUST HAVE EITHER THE PHA MODULE INSTALLED (FOR PULSE HEIGHT ANALYSIS) OR THE SHORTING HEADER INSTALLED (NO PHA).
4. A2 IS USED ONLY FOR SPECIAL APPLICATIONS.
5. FOR ALPHA/BETA OPTION: S31 IS REMOVED, TRACE BETWEEN 'T' AND 'A' IS CUT, JP1 IS INSTALLED, WINDOW POT R32 IS REPLACED WITH A 20K POT AND S32 IS WIRED TO PADS A, B T AND W.

ASP-1 Schematic (11338-D01^K) Sht. 1 of 2



SEE SHEET 1 FOR NOTES

ASP-1 Schematic (11338-D01^K) Sht. 2 of 2



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Component Layout, Optional PHA Board 11340-C03^{B}

SECTION VII
DETECTORS AND ACCESSORIES

NO.	MODEL NO.	TYPE	TYPICAL DETECTION	NOMINAL HIGH VOLTS	TYPICAL RATE UNIT	APPROX. USEFUL RANGE	BASIC SENSITIVITY CPM PER RATE UNIT	I.S. mV (NO PHA)	DEAD TIME SETTING μs	MULT DIAL	CALIBRATION SWITCHES		STD CURR SETTING CAL POT ADJUST	LOW EXPOSURE (CAL SWITCHES AND CAL POT)	HIGH EXPOSURE (DEAD TIME SWITCHES)
											3	4			
1	AC-3-7, AC-3-8	Scintillator	Alpha Contamination	1000 V (see note 1)	True cpm	Background to 2M	One cpm per cpm	2	6	X10M-X100	CLOSE	OPEN	.49	50k cpm*** 2π Emission	5M cpm*** 2π Emission
2	AC-3-7	Scintillator	Alpha Contamination	1000 V (see note 1)	Source 2π cpm	Background to 6M	0.3 cpm per cpm****	2	6	X10M-X100	CLOSE	CLOSE	.52	50k cpm 2π Emission	5M cpm 2π Emission
3	AC-3-8	Scintillator	Alpha Contamination	1000 V (see note 1)	Source 2π cpm	Background to 6M	0.2 cpm per cpm****	2	6	X10M-X100	CLOSE	CLOSE	.78	50k cpm 2π Emission	5M cpm 2π Emission
4	HP-190A	GM	Beta Contamination	900 V	cpm	Background to 1.5 m	1 cpm per cpm	10	230	X10M-X100	* CLOSE	* OPEN	.49*	25 mR/h	250 mR/h Set dead-time switch for 10 times 25 mR/h reading
5	HP-190A	GM	Gamma Exposure	900 V	mR/h	Background to 600 mR/h	2500 cpm per mR/h	10	230	X1k-X.01	CLOSE	CLOSE	.62	25 mR/h	250 mR/h
6	HP-210L, HP-210T, HP-260	GM	Beta Gamma Contamination	900 V	cpm	Background to 3.6 m	1 cpm per cpm	10	80	X10M-X100	* CLOSE	* OPEN	.49*	72k cpm 20 mR/h**	3.6M cpm 1 R/h**
7	HP-210L, HP-210T, HP-260	GM	Gamma Exposure	900 V	mR/h	Background to 1000 mR/h	3600 cpm per mR/h	10	80	X1k-X.01	CLOSE	CLOSE	.43	10 mR/h	750 mR/h
8	HP-270	GM	Gamma Exposure	900 V	mR/h	Background to 3000 mR/h	1200 cpm per mR/h	10	112	X10k-X.1	OPEN	OPEN	.73	20 mR/h	1 R/h
9	H-270	GM	Gamma Exposure	900 V	μGy/h	Background to 30k μGy/h	120 cpm per μGy/h	10	112	X100k-X1	OPEN	OPEN	.73	200 μGy/h	10 μGy/h
10	HP-290 or Internal Detector	GM	Gamma Exposure	550 V	mR/h	0.1 to 60k mR/h	83 cpm per mR/h	10	20	X100k-X1	CLOSE	OPEN	.59	500 mR/h	25 R/h
11	HP-290	GM	Gamma Exposure	550 V	R/h	Background to 60 R/h	83k cpm per R/h	10	20	X100-X.001	CLOSE	OPEN	.59	0.5 R/h	25 R/h

* This data applies if calibration is to true pulse rate from detector. If calibration is to source value, standard current and the calibration switch will vary according to efficiency. (Example: If Efficiency = 33-1/3 percent and calibration to source is required, true cpm input will be 1/3 of the source value cpm. The calibration switch would be 3-CL, 4-CL, and standard current reading would be .44).

** Recommended intial setup with gamma to permit setting of dead-time switches without consideration of particle efficiency of the detector. Otherwise, low exposure source would nominally be 72k cpm ÷ efficiency and high exposure source should be 3.6M ÷ efficiency.

*** Use 2π emission rate multiplied by detector efficiency to get true counts coming from the detector.

**** Typical efficiency.

NOTE 1 Detector voltage should be set as described in the "Maintenance" section of the ASP-1 manual.

Table 7-1. Detector Information, Nominal Values

NO.	MODEL NO.	TYPE	TYPICAL DETECTION	NOMINAL HIGH VOLTS	TYPICAL RATE UNIT	APPROX. USEFUL RANGE	BASIC SENSITIVITY CPM PER RATE UNIT	I.S. mV (NO PHA)	DEAD TIME SETTING μs	MULT DIAL	CALIBRATION SWITCHES		STD CURR SETTING CAL POT ADJUST	LOW EXPOSURE (CAL SWITCHES AND CAL POT)	HIGH EXPOSURE (DEAD TIME SWITCHES)
											3	4			
12	HP-290	GM	Gamma Exposure	550 V	μGy/h	Background to 600k μGy/h	8.3 cpm per μGy/h	10	20	X1M-X10	CLOSE	OPEN	.59	5 μGy/h	250 μGy/h
13	HP-290	GM	Gamma Exposure	550 V	mGy/h	Background to 600 mGy/h	8.3k cpm per mGy/h	10	20	X1k-X.01	CLOSE	OPEN	.59	5 μGy/h	250 μGy/h
14	LEG-1	Scintillator	Low-Energy Gamma or X-ray	1000 V (see note 1)	cpm	Background to 2.4M	1 cpm per cpm	2	8	X10M-X100	CLOSE	OPEN	.49	Exposure for 80k true cpm detector output	Exposure for 30 times as strong as low exposure. Set dead time for 2.4M cpm.
15	LEG-1	Scintillator	Low-Energy Gamma or X-ray	1000 V (see note 1)	cps	Background 40k cps	60 cpm per cps	2	8	X100k-X1	OPEN	CLOSE	.46	Exposure for 100 true cps detector output	Exposure for 30 times as strong as low exposure. Set dead time for 30k cps.
16	NRD	Proportional Chamber	Neutron Dose Equivalent	1800 V (see note 1,2)	mrem/h	1 to 60 K	45 cpm per mrem/h	2	10	X100k-X1	OPEN	CLOSE	.62	20 mrem/h	120 rem/h
17	NRD	Proportional Chamber	Neutron Dose Equivalent	1800 V (see note 1,2)	rem/h	0.001 to 60	45k cpm per rem/h	2	10	X100-X.001	OPEN	CLOSE	.62	0.02 rem/h	120 rem/h
18	NRD	Proportional Chamber	Neutron Dose Equivalent	1800 V (see note 1,2)	μSv/h	2-600 K	4.5 cpm per μSv/h	2	10	X1M-X10	OPEN	CLOSE	.62	200 μSv/h	1.2 Sv/h
19	NRD	Proportional Chamber	Neutron Dose Equivalent	1800 V (see note 1,2)	μSv/min	.05-10K	270 cpm per μSv/min	2	10	X10k-X.1	CLOSE	CLOSE	.58	3 μSv/min	18k μSv/min
20	SPA-2, 1 × 1 Crystal	Scintillator	Medium Sensitivity Gamma	1000 V (see note 1)	cpm	Background to 2.4M	1 cpm per cpm	10	12	X10M-X100	CLOSE	OPEN	.49	Exposure for 40k true cpm detector output	Exposure for 50 times as strong as low exposure Set dead time for 2.0M cpm.

* This data applies if calibration is to true pulse rate from detector. If calibration is to source value, standard current and the calibration switch will vary according to efficiency. (Example: If Efficiency = 33-1/3 percent and calibration to source is required, true cpm input will be 1/3 of the source value cpm. The calibration switch would be 3-CL, 4-CL, and standard current reading would be .44).

** Recommended intial setup with gamma to permit setting of dead-time switches without consideration of particle efficiency of the detector. Otherwise, low exposure source would nominally be 72k cpm ÷ efficiency and high exposure source should be 3.6M ÷ efficiency.

*** Use 2π emission rate multiplied by detector efficiency to get true counts coming from the detector.

**** Typical efficiency.

NOTE 1 Detector voltage should be set as described in the "Maintenance" section of the ASP-1 manual.

NOTE 2 Do not exceed 2100 volts on NRD.

Table 7-1. Detector Information, Nominal Values

NO.	MODEL NO.	TYPE	TYPICAL DETECTION	NOMINAL HIGH VOLTS	TYPICAL RATE UNIT	APPROX. USEFUL RANGE	BASIC SENSITIVITY CPM PER RATE UNIT	I.S. mV (NO PHA)	DEAD TIME SETTING μs	MULT DIAL	CALIBRATION SWITCHES		STD CURR SETTING CAL POT ADJUST	LOW EXPOSURE (CAL SWITCHES AND CAL POT)	HIGH EXPOSURE (DEAD TIME SWITCHES)
											3	4			
21	SPA-2 1 × 1 Crystal	Scintillator	Medium-Sensitivity Gamma	1000 V (see note 1)	cps	Background to 40k cps	60 cpm per cps	10	12	X100k-X1	OPEN	CLOSE	.46	Exposure for 1k true cps detector output	Exposure for 30 times as strong as low exposure. Set dead time for 30k.
22	SPA-3	Scintillator	High Sensitivity Gamma	1000 V (see note 1)	cpm	Background to 2.4M	1 cpm per cpm	10	14	X10M-X.100	CLOSE	OPEN	.49	Exposure for 200k true cpm detector output	Exposure for 10 times as strong as low exposure. Set dead time for 2.0M cpm.
23	SPA-3	Scintillator	High Sensitivity Gamma	1000 V (see note 1)	cps	Background to 40k cps	60 cpm/cps	10	14	X100k-X1	OPEN	CLOSE	.46	Exposure for 3k true cps detector output	Exposure for 10 times as strong as low exposure. Set dead time for 30k cps.
24	SPA-6	Scintillator	Medium-Sensitivity Gamma	1000 V (see note 1)	cpm	Background to 2.4 M	1 cpm per cpm	10	12	X10M-X100	CLOSE	OPEN	.49	Exposure for 100k true cpm detector output	Exposure for 20 times as strong as low exposure Set dead time for 2.0M.
25	SPA-6	Scintillator	Medium-Sensitivity Gamma	1000 V (see note 1)	cps	Background to 40k cps	60 cpm per cps	10	12	X100k-X1	OPEN	CLOSE	.46	Exposure for 2k true cps detector output	Exposure for 15 times as strong as low exposure. Set dead time for 30k.

* This data applies if calibration is to true pulse rate from detector. If calibration is to source value, standard current and the calibration switch will vary according to efficiency. (Example: If Efficiency = 33-1/3 percent and calibration to source is required, true cpm input will be 1/3 of the source value cpm. The calibration switch would be 3-CL, 4-CL, and standard current reading would be .44).

** Recommended intial setup with gamma to permit setting of dead-time switches without consideration of particle efficiency of the detector. Otherwise, low exposure source would nominally be 72k cpm ÷ efficiency and high exposure source should be 3.6M ÷ efficiency.

*** Use 2π emission rate multiplied by detector efficiency to get true counts coming from the detector.

**** Typical efficiency.

NOTE 1 Detector voltage should be set as described in the "Maintenance" section of the ASP-1 manual.

Table 7-1. Detector Information, Nominal Values